# THE

# JOURNAL

OF THE

# ROYAL AGRICULTURAL SOCIETY

# OF ENGLAND.

VOLUME THE NINTH.

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PRACTICE WITH SCIENCE.

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LONDON:
JOHN MURRAY, ALBEMARLE STREET.

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Von Thaer, *Principles of Agriculture.*

London: Printed by William Clowes and Sons, Stamford Street.

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## PLATES.



## DIRECTIONS TO BINDER.

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*The Index to Vols. I.—VIII. is given with this Part.*

# JOURNAL

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# ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

## I.—*The Management of Grass Land.* By ROBERT SMITH, late of Burley, Rutland.

### PRIZE ESSAY.

THE *Grasses*, numerous as they are, may be truly spoken of as indigenous to the whole earth: they seem to arise spontaneously, and are found to clothe the surface of every zone, taking a substance varying according to the soil and climate, and forcibly pointing out the importance of assimilating our modern culture to the waywardness of nature. The best grasses—those which are most productive and nutritive—are found in the more *even* climates—such climates as have the least cold in winter, and no excess of heat in the summer: these attain a greater length and have less bottom-grass in the warm climates; and in the cooler ones there is a preponderance of bottom-grass, it being there found to spread more evenly or thicker near the ground, is of a darker green appearance, and less subject to run up to bents.

No department of agriculture is more simple in execution than the general culture of the grasses; yet, from their great variety, and required adaptation to the various soils, &c., considerable judgment is necessary to carry out new designs, and to effect permanent improvements on the old grass or meadow lands.

In entering upon the general details of the effective management of grass lands, viz. " The actual practice in the management of downs and inferior pastures, meadows, and grazing-ground," it is advisable to treat upon each description separately, as the management should vary according to the influence of local circumstances; for there is a difference in the productive powers, each class having its peculiar affinities and functions in the vegetable kingdom.

It is a matter not unworthy of comment, that while every agricultural publication teems with information of every order for the

advancement of the arable department, we rarely meet with the record of a single experiment for the improvement of grass lands, although it is well understood that this branch of agriculture is expected to furnish the majority of the supplies of both beef and mutton during the summer months. Moreover, seeing that the main skill and enterprise of the agricultural order is particularly directed to the united production of cattle, sheep, and corn, by the adoption of the "alternate husbandry" (and in many instances regardless of the "old grass lands"), the theorist is led to dwell upon the *apparent* working of the subject, and to draw the conclusion that the arable land must be more grateful for the extra labour and artificial aid supplied, and consequently the quickest and more certain in its return. This, it is important to remark, is daily confirmed in practice; for it is found that the majority of occupiers endeavour to increase their arable lands by obtaining permission to break up a portion of their grass lands, though it is a novelty to find them laying down arable lands to permanent pasture. Hence it happens that a large proportion of the grass lands of England remains unimproved, and in many instances neglected, particularly in those districts where there is an over abundance of grass land in proportion to the arable, which occurs in some districts to an enormous extent. This is fully shown by the following extract from Spackman's 'Analysis of the Occupations of the People,' p. 35 :—

| | Statute Acres. |
|---|---|
| Amount of arable lands and gardens . | 10,252,800 |
| Meadows, pastures, and marshes . . | 15,379,200 |
| Wastes capable of improvement . . | 3,454,000 |
| Incapable of improvement . . . | 3,256,400 |
| Total acreage of England . . . | 32,342,400 |

The *Grazing-ground*, or what is usually termed the "old grass land," abounds most in the midland, eastern, and marshy districts of the northern counties. which are usually termed the grazing districts, whence the principal midsummer and autumnal supplies of fat cattle and sheep are drawn for the London and northern markets. The grazing-ground, on farms of any size or importance, is generally divided under two distinct heads, rich old pastures being designated and treated as "ox-land," and the middle or second-class pastures as "sheep-land." The latter is, however, frequently used to a great extent for cattle, and is perhaps more generally known as store or breeding land, though it is regulated entirely by the nature of the occupation.

The *Ox-land* consists of that portion of the occupation which has been under natural grass from time immemorial. It is found to exist and flourish most on those plots which have the greatest

depth of soil, the period of production varying according to the character of the subsoil on which they are found. For instance, upon gravelly subsoils the grasses are exceedingly early in their spring-shoot, and they retain their vigour until impeded by the increased warmth of the summer sun's rays: the then standard of heat proves too great for that character of soil, and the grasses remain dormant for a considerable portion of the summer, but rally again as the season advances, when they become exceedingly valuable pastures to succeed other descriptions of soil. In the treatment of these soils nothing of importance is required beyond the usual routine. They are generally free from weeds, and require no draining; but they are grateful for light dressings of manure during the winter months, although preference is given to a mixture of soil with salt or lime; after this they are closed for early grass, and are usually ready for stocking in the early part of April. Careful graziers place their forward or prepared oxen upon them by degrees, increasing the quantity of stock with the increase of pasture; the oxen are usually taken back at night to their yards or winter-quarters during this month. In situations at a distance, however, the animals are provided with good shelter, and a liberal supply of stubble or refuse straw is thrown in a convenient corner of the field for them to rest upon. This is a prudent, and indeed a valuable practice, as the cattle are by it induced to leave the pastures during the night, and thus their manure is deposited off the land, and the pasture is allowed to sweeten. Hay or artificial food is supplied about the spot, which adds materially to the value and growth of the pasture, especially when frosty mornings occur. The manure thus raised is reserved for the weaker portions of the field, and applied the following winter.

After the first run of oxen have been sent to market, which is usually terminated by the season, these pastures are cleaned up, the clots are gathered or knocked, and the weeds (if any) removed by mowing or spudding. At the end of three weeks, or according to the season, they are again moderately stocked with cattle from the sheep or second-class pastures. About September a few sheep are placed upon them, but not earlier, as these dry soils will not admit of their short bottom-grass being eaten out during the summer months. The next stage of management is to place the store-stock upon them for cleaning up the surplus summer-grass, or what is termed "fog," it being exceedingly desirable to have an *entire* clearance at least once a-year.

Those lands which are closely fed, and consequently contain less "fog," have but few beasts placed upon them, though they are usually more heavily depastured with sheep. These soils, from their dry and consequently warm character, are considered

valuable winter-pastures for sheep, which, with attention and some artificial aid, are frequently ready for market when the period arrives for closing the pastures to prepare for early grass.

Pastures resting upon a *clay* or *cold* subsoil vary materially in their periods of production from those upon gravel, they being more backward in the spring (through the absence of warmth); but they are found to progress with the summer, and are indeed most nutritive during the hottest months. These pastures are not usually cleared of their winter-stock until about the 1st of April, when they are cleaned up, and allowed to remain until ready to receive the cattle. The period depends entirely upon the temperature of the spring, as in some situations they vary as much as from 10 to 15 days in the period of stocking, which proves inconvenient to the occupier.

The surface-soil of these pastures, being perfectly dry though resting upon a cool subsoil, is very durable, and carries a heavy proportion of stock, which improve rapidly and become exceedingly good. The old pastures rarely require resting during the summer beyond a short period for sweetening, when the cattle are removed to market. In the best-managed districts the clots are regularly gathered and the weeds kept down, which asssists materially in keeping an even pasture ; thus, when properly cultivated, they run less to bunches or "fog" than others. The general herbage is of an even and sweet character, arising from the cool and healthy subsoil. About one sheep per acre, with nearly an ox, is the general run of stock placed upon them in the commencement: care being taken to have the sheep fat and removed to market soon after clip-day. The bottom herbage then advances, and improves the pasture for the cattle. When these cattle are removed, the fields are again supplied from the inferior pastures, and in many instances about two sheep per acre are placed upon them, with a proper quantity of cattle, all of which, by the end of the season, are sufficiently fat for market. The store or winter beasts then follow to clean up, and are allowed to remain according to the situation and local circumstances.

These pastures carry at least two sheep per acre during the winter months, but do not make them so fresh in condition as the warmer soils.

It is somewhat remarkable to state that we rarely if ever find these soils assisted in any way by artificial means beyond the return of the manure that may have been gathered during the summer months: hence the value that is usually placed upon these old pastures, they being exceedingly productive and nearly free of expense, both as regards manual labour and artificial aid.

The rich pastures resting upon a deep and healthy subsoil are found to produce more bulk of grass than any other; but in some cases the grass is wild and coarse in its growth, as, from the richness of soil and immense range the roots enjoy when in search of their food, a corresponding growth or rapid increase is produced in the foliage. The rich pastures or soils are found most in the inland and warmer districts, and are truly designated in those localities the fine old "ox-lands," which are much sought after by the leading or principal graziers, as they are known to fatten an ox or sheep of any size, and, in many cases, regardless of quality. It is truly difficult to define any plan of management in regard to these pastures, they being rarely cleared or rested the whole year round; it is found requisite to continue the winter-beast in the pastures up to the latest period, to effect a clearance of the "old fog" left over from the preceding summer. In such cases they are frequently allowed to remain throughout, and others are added to them as the grazing season advances. In some districts the practice is to winter lambs upon these pastures, particularly in Leicestershire; and they are never removed until fat for the butcher—about the end of the following August or beginning of September. In other districts, however, either shearlings or barren ewes are placed upon them, and drawn off early in the season; a desirable process.

These pastures, from their quick growth and strength of herbage, are generally stocked with oxen of a good age; some occupiers in the western districts prefer heifer or cow stock for supplying the manufacturing population.

In either case a second run is provided about the middle of of the summer, at which period many graziers prefer to "skim" these pastures over, thereby checking the rough bunches and grasses that predominate, and giving a more even pasture to the succeeding cattle.

The winter management is that of the soils before treated on; cattle and sheep in sufficient number being placed upon them to effect a proper clearance of the rough grass previous to the 1st of May. The cattle depastured upon these soils during the winter months rarely receive any extra food, except in extreme weather; as they are found, when allowed fodder, to be more restless and less inclined to effect a clearance of the "rough grass," for which purpose they are expressly provided, and may (under the circumstances) be said to cost nothing for wintering. This class of animals are fatted or cleared off for the London market about the succeeding Michaelmas, and are generally termed the Leicesters, as they are principally used in that and the surrounding districts. In those districts where less shelter is found and part of the occupation is arable, it is customary to allow the

cattle to go out during the day to clean up the nearest pastures and return to the yards at night. Nothing occurs in their management different from that of the preceding pastures; the grasses are really indigenous productions, formed upon an accumulated mass of vegetable mould, and are of themselves sufficiently rich without the aid of manures: they require, however, to be kept in proper bounds, that every remaining blade be allowed to see the sun at least once a year, otherwise an accumulation of rough grass takes place, and the herbage becomes degenerated, changed in character, and less nutritive in quality. Hence we often hear parties remark that certain fields have lost their feeding qualities; this results from the fact that, while the annual produce of the soil is chiefly exported in the shape of beef, mutton, &c., and no return of manure is made to the soil, the grasses themselves have been allowed to be choked with superfluous rubbish and not even permitted to adjust themselves according to "Nature's course." The importance of assisting Nature, rather than marring her works, is forcibly shown in this.

The *second* class, or sheep-land, consists of those soils and pastures which are generally termed "middle descriptions of grass lands," and are found to abound more or less in nearly every district in England. They consist chiefly of two classes of soils, viz. the dry soils, such as rest upon dry or open subsoils, and those resting upon cold or moderate subsoils.

The *dry* soils comprise those pastures which are more rapid and early in their produce during the spring months, thus proving exceedingly valuable to the occupier, it being a great relief to have a portion of early pasture-land.

These pastures are usually cleared at an early period, and in some instances even before Christmas, in order that they may prove the more valuable in the spring. As the grasses produced by these descriptions of soils are of a *fine* character, it is thought best to allow them to get a good *cover* previously to placing the whole summer stock upon them. By this process they are less liable to be burned or parched up, carry more sheep per acre, make a better return, and the lands are more improved, than when stocked at an early period.

Young or second-class beasts are added in proportion to the character of the herbage, as some soils throw up more bents or seed-shoots than others. What is termed the full stock is allowed to remain upon these lands until the first class, or ox-land, is cleared and ready to receive a portion of them; after which thinning, the pasture improves materially, and the remaining stock do exceedingly well. From the dry and healthy character of these lands they are depastured with sheep during the winter in preference to cattle, the latter being entirely removed in October.

The sheep are then found to enjoy themselves, and get exceedingly forward in condition, and in many instances they are sold fat at the end of the season, or removed to the turnip lands. It is the custom to clean up the pastures about Christmas. It rarely occurs that any artificial aid is given to these soils beyond the sheep manure, which upon some soils is considerable, and certainly adds much to the improvement of the herbage. Upon the more shallow soils a dressing of soil and lime is given by the best managers, when cleaned up for a pasture—the weeds being removed as they occur during the summer months.

From the peculiar nature of these soils they are both easy and cheap in their management, the principal point being that a proper amount of herbage should accumulate in the spring before the full stock is placed upon them, as these soils are more dependent upon seasons than any other class.

The pastures which rest upon cold or moderate subsoils are considered productive summer pastures for sheep and cattle, a preference being given to such as are found upon healthy clay bottoms. Their management is widely different from that of the dry soils, but when combined in one occupation they assist each other and become more profitable.

From the cool temperature of these soils they are rather backward in throwing up their spring-shoots; but when well started they soon form a thick, green, nutritive herbage, especially on the clay subsoils when free from surplus water, but in every case where water exists the pastures are both thin and backward—in fact, of little value. Hence the importance of draining. From the thickness of herbage produced by the best of these soils, little fear is felt as to their being overstocked with sheep at the commencement of the season; they also require heavily stocking with cattle for a time to keep the seed-shoots down, in order that the pasture may wear an even herbage, the all-important point in the culture of these pastures. As the season advances, the sheep (being feeding-stock) are thinned out from time to time for market, by which means the pastures are regulated to the greatest nicety. The cattle are drafted to the ox-lands as required.

Some of the more moderate soils are grazed with store-stock, according to their produce. The best pastures are heavily stocked with sheep throughout the winter, and to a late period in the spring. In many districts when depastured with feeding sheep, the animals are allowed a few beans, a plan by which they are certain to be ready for market at an early period. This practice I consider a good one.

In the best districts the good pastures are kept clean throughout the season, care being taken to watch the outfalls and master-drains, as well as to place in short drains at any part of the field

where they may be required to complete the general drainage. By this kind of attention the annual outlay is kept at a moderate rate, and the pastures are gradually improved. By the constant close or sheep feeding of these pastures, a great deposit of valuable manure is made upon them; the surface-soil becomes immensely improved, not only by the deposit, but by means of the working of the various insects in search of food, by whose aid the manure is let down, and the surface-soil thrown up; the deposit being thus mixed and the vegetable matter decomposed. It is quite certain that a more suitable dressing or stimulating food could not be prepared for these grasses; and as practice daily shows the importance of close feeding these pastures, I do not apprehend that the practice I have detailed can be improved, especially upon the deep even class of soils. In situations, however, where veins of thin or more moderate soils intervene, it is desirable to give such portions a thin dressing of manure or compost.

It is especially worthy of remark that the best thick-bottomed sheep pastures are found in the marshy districts, such as have at some former period been rescued from the sea, or are found within reach of the salt-water spray, upon which sheep are found to be exceedingly healthy; a fact indicating the importance of salt, both as a fertilizer for pasture-lands and a promoter of health as regards cattle and sheep.

*The downs and inferior pastures* form two distinct subjects. The downs include the dry and many hilly pastures. The inferior pastures may be found in every locality, and they vary in their character even from field to field.

The downs or sheep-walks in the South and West of England are thin of soil, and usually rest upon an inert subsoil: consequently they are difficult to improve by profitable means, and are allowed to remain in their natural state. Large tracts of these lands are held with arable farms as sheep-walks; they are treated adversely, being depastured with sheep during the day; the animals collect the mixed produce, and are conveyed to the fold at night, there to deposit the produce of the heath, for the improvement of those soils that have been taken in for the purpose of growing corn, and the general class of downs, left to chance, producing more or less, according to the moisture of the season. Some portions of the better or deeper soils have been ploughed up and renewed with the modern grasses. But this process is not found to answer, unless the soil be materially assisted or changed in character, as, when unimproved by stimulants during the transfer, they gradually return to their original state, and the indigenous grasses as soon preponderate.

The natural produce of the downs is of small bulk, but it is found both wholesome and palatable to sheep.

From the elevated position of the general class of downs, they are found particularly healthy, and valuable in connection with other occupations.

The *hilly* pastures are of two classes: the moderately elevated and low hills, which are rarely approached by the plough; and the high hills, which, from their acclivity and elevation, are necessarily appropriated to stock of a local character, and are found productive and useful in their order. The moderate or low hills (such as produce fine short herbage) are found more governable, and are for the most part depastured with sheep. At the base of these hills herbage is frequently found sufficiently rich for fattening sheep, or the breeding and rearing of them. Those hills of moderate acclivity with a sufficiency of soil are capable of great improvement, particularly where blocks of even ground are intermixed with them; in support of which I may refer to the marked results of those districts or farms on Exmoor, Somersetshire; which have been recently renewed by means of paring and burning the natural herbage, and then supplying lime to the soil previous to its being again laid down to grass. After the burning and liming have been completed, these lands have been prepared and sown with root crops, followed by oats, the grass-seeds being sown with them, or sown down without a crop of corn; in such case a little cole-seed might be mixed with it, which would afford excellent keeping for sheep in the autumn; the latter would, I think, be the better practice when the land is intended for permanent pasture. Such fields as have had the largest portion of lime given them are found to produce excellent roots, oats, and grass; and, when depastured a few years, make an excellent appearance and form a thick herbage, while those which have had a moderate supply of lime show the improvement only in a corresponding degree. Again (to show the value of lime), on such parts as have been renewed, and have received no lime, the grasses are gradually returning to their former indigenous character. In the absence of the process of renewal, much good has been effected on these native grasses by the application of a top-dressing of lime, thereby causing the modern grasses to spring up, and to a great extent eradicate the former occupants.

The aspect of pasture-lands in the hilly districts forms an important proof of the principle of *warmth*, as we find those lands sloping to the south, or receiving the rays of the sun more directly, to be influenced most in their productive or vegetating powers, while those hanging to the north are less productive and of a different character.

In fact, such is the importance of aspect, that we find on close observation that the natural grasses vary both in number and character. If a survey be taken round even a moderate hill, this

will be evident; in fact, in no instance is the varied temperature of the soils more forcibly shown than in hilly districts. The pastures upon the southern aspects are found exceedingly useful, while those upon the northern sides frequently abound in rough sour grasses, in some instances scarcely worthy of occupation.

The *inferior* pastures, although numerous in their class and almost numberless in their character, may be treated under two heads, viz. the dry thin soils, and the cold or wet soils. Each is governed more or less by the nature of the subsoil, and other local difficulties it may have to contend with.

The inferior dry soils are those of a thin character, resting upon subsoils of a stony, rocky, or other dry formation. The improvement of these pastures, from their thin and frequently unprofitable nature, is very little attempted, particularly by temporary occupiers, or even those of an annual tenure. Those occupiers who have long leases, or have a guarantee from their landlords to be paid for unexhausted improvements, are found to be most active in the improvement of these soils; they bring them under arable culture for a time, and then lay them down to grass again for a period of years. The former class of occupiers are too frequently prevented by some covenant from carrying out these marked improvements, hence their indisposition to spend money upon an uncertain occupation, particularly to improve "inferior grass land." With uncertain tenure they should be treated as permanent improvements, and aided by the landlord. The manures or dressings applied to these pastures are numerous, care being taken to supply each character of soil or herbage with its required food, either in the shape of artificial manure or compost. It is not uncommon to throw over the pastures a small quantity of mixed clover and hay seeds, suitable to the soils. These pastures, from their thinness of soil, are improved most by dressings of compost, it being found advantageous to increase and mix the texture of the natural soil with that of a more opposite character—thus, surplus soil, scouring of ditches, banks, weeds of any kind, road-scrapings, clots, or even any rubbish, may be collected into a heap and mixed with lime, which quickly decomposes the collection, and, after a few turnings, forms an excellent compost to be applied about Christmas, or when the pastures can be spared for such purpose. In the event of moss or other small weeds abounding in the pastures under improvement, a pair of harrows are found of infinite service in removing them. After this operation a small quantity of grass-seeds should be sown over the field (previously to the compost being applied), and by attention to the spreading and bushing the field the whole surface becomes apparently changed. After a short time has elapsed the iron roller is applied with immense

advantage: in fact, the heavy roller is an invaluable implement when freely applied to grass lands—instance those parts of a field that have been by various occupations pressed or carted upon more that the average parts of the field—and we find them producing a different class of grasses, much greener in their appearance and more nutritive in use; they are more eagerly sought after by every description of stock, and, while other parts of the field may be found to have "run away" in abundant seasons, these parts are always found fed down to the very roots.

This shows the importance of assimilating the management of these pastures to those accidental, yet valuable, dictates—pressure and close feeding.

Again, in connection with these soils it is important to remark that, in every case where the soil has been by one cause or other increased and darkened in its appearance or character, it is found more productive and much earlier in its spring shoot; in fact, the grasses themselves have changed with the accumulation of this new matter.

In no instance is this process better shown in practice than by pointing to hedge-sides, çorners, or other sheltered parts of a field which the cattle or sheep have frequented most; and on many of the first-class soils, such as the "ox-pastures," we find that, if care be not taken to check the accumulation, those parts of the field become wild and so coarse in their growth, that even oxen refuse to eat them after the first shoot has been taken off.

A variety of artificial manures as top-dressings or stimulants are used for improving these pastures, such as nitrate of soda, guano, lime, salt, bones, soot, &c.; but as the pastures neither throw up nor contain any amount of vegetable matter, a preference is given to a staple manure, or prepared compost, &c.

The draining of this description of soils is rarely attempted, for they are generally found resting upon stony or other porous subsoils. Yet we often find even pastures which are liable to be burned up improved by draining; the roots, having but little depth of earth to range in, become exhausted, as they refuse to enter the noxious substances contained in unhealthy subsoils. But, when properly drained, the rains that fall will gradually wash out the noxious matter, and the roots will follow to a great depth, and ultimately receive a more abundant and certain supply of food from the thus increased and improved depth of healthy soil. The more profitable occupation of these soils or pastures is the transfer of the greater part of them to arable culture, whereby whole districts would be improved, and even a greater amount of beef and mutton supplied from them (in addition to the corn produced) for an increasing population, as also supplying the agricultural labourer and artisan with additional employment.

Hence the connection of this subject with the great chain of rural economy, as also advancing to the yet distant but approaching standard of "commercial principles" in regard to the general tenure and culture of the soil.

The folding of sheep upon dry soils under improvement is found to answer remarkably well, and its effects are visible for many years: it darkens the soil, as well as confers a stimulating dressing. The result is particularly visible on those situations which sheep select for their lair during the night—the dry warm banks or parts of the field that have been casually drained. Liquid manure, or compost that has been prepared with it, has also a good and similar effect upon pasture lands. In fact, any dressings that stimulate the growth of the herbage or decompose the vegetable matter have the effect of expanding and increasing the surface-soil to a great extent. This is very perceptible on stony soils, as the stones gradually disappear and become enveloped by the rising soil accumulated by the numerous earthworms and other minute insects thus set to work, and which bring up their burden of fine fertilizing earth, particularly when pastures are rested or cleared for a few weeks, after being heavily depastured with sheep. The heavy roller then admirably completes the work, and the improvement becomes fixed and permanent, provided care be taken to repeat the dressings for a few years.

The soil under this process becomes closely assimilated to the rich soils that have been naturally formed or increased through former ages, and which are now properly designated the "rich old pasture lands;" it being evidently a work of time to produce those acquired rich and fertilizing properties.

The *cold or wet* inferior soils are those resting upon subsoils of that nature, which have as yet been more or less neglected, as they hold out but little encouragement to the tenant occupier to improve them; still by the application of skill and capital even in these soils important changes are effected. In the general management of these pastures it is usual, when unimproved, to stock them with young beasts or horses, and but rarely with sheep, as their herbage is of so coarse a nature as to forbid sheep being fed upon them. Those that have been drained are found improved, but in due proportion to the plan and extent of draining performed.

Where shallow drains have been put in, the herbage is but slightly changed, as many of the aquatic grasses still remain and find support in the yet reachable watery subsoil, while those that have been properly drained at a greater depth show the good effects by the changed appearance, which by close feeding with cattle and horses become useful store land, particularly when attention has been paid to give them a top-dressing of lime, salt,

bones, or other artificial manures in the spring. By such means the grasses become improved and sweetened, and are eaten up much closer, which is the great desideratum to effect a change in the herbage of any pasture under improvement.

In low swampy situations, a few really deep drains, laid round or across the fields according to situation, have frequently had the effect of not only laying the particular field dry, but many of the surrounding ponds; in fact, the worse the land the deeper the drains should be. Yet the remark that land has been over-drained is familiar in many districts; hence it is inferred that the pastures have been spoiled. Now this inference is inapplicable to the draining, the soil being changed for the better! The food of the aquatic grasses having been removed, they become dry and inactive: it is true the existing grasses become more like stubble than grass. But having so far changed the soil, it is equally necessary to change the herbage, by other agents—such as suitable top-dressings to sweeten and increase the herbage, that the truly important branch of close feeding may be effected. The pasture then becomes gradually improved, and nature supplies her indigenous grasses, suitable to the then improved character of the soil, as the aquatic or other spurious grasses in the absence of their food decline.

Those grasses found upon moderately good surface soils resting upon subsoils that have a coat of peat earth upon them, between the lower strata of clay and surface soil, are slow in their improvement; although ranging in good districts and surrounded with excellent cropping land, they carry but little stock, and prove an unprofitable occupation: such pastures require renewing, whereby the more modern grasses would be sown, and consequently meet the changed composition of the soil. After this each field would be doubled in value for grazing purposes, but of still greater value if kept under the plough.

From the apparent slow progress made in the improvement of the general class of inferior pastures by the tenants, it is evidently a permanent or landlord's question. Possibly the better plan for both is to meet halfway, the landlord finding materials, and the tenant performing the workmanship. A sound scale for general improvements might indeed be adopted, and "two blades of grass might be raised where only one grew before"—the one by the landlord and the other by the tenant.

The lands laid down to artificial grass in connection with the arable culture of a farm, for one, two, or more years, are also worthy of notice, as they show the principle by which general improvements may be effected, either with a view to rest the arable lands for a time or to remain for permanent pasture. In the latter case it is alike important and interesting to notice the

effects of nature in connection with the food of these grasses: we find that when the soil has not been properly prepared, or the modern grasses properly selected, or the soil has been exhausted of the particular food suitable to the selected grasses, the indigenous ones spring up; hence the slow return from these newly-formed pastures during the period of conversion, or while they are adjusting themselves, "under Nature's care," to the soil and situation. They gradually form a thick sward of rich and nourishing herbage upon well-cultivated soils, but are of moderate worth when sown upon neglected or worn-out arable lands: the mere laying down to grass will not make good pasture lands, however long they may remain; of this the commons, heaths, downs, &c. afford sufficient proof. Lands laid down to pasture, with or without a corn crop, are known in practice to form separate or distinct results, particularly in after years. Those laid down in corn crops are a considerable time in forming good pasture lands, while those laid down without a crop of corn (when the soil is properly prepared) become at once exceedingly rich and fertile, and represent an improved temperature. Being enabled to absorb more of the sun's warmth, they continue to have a very perceptible lead of those grown in the corn crop, by which the soil to a great extent has been also exhausted; the grasses are consequently less luxuriant in their growth. This is an important feature when it is considered that the young grasses (clover in particular) derive support from the atmosphere in due proportion to their strength of foliage or growth produced by the food supplied them in the soil; hence the herbage to be consumed and the growth of the roots are found to progress in a corresponding ratio: yet however striking these results may appear, they form but another proof of the importance of good cultivation blended with a proper knowledge of natural tendencies.

*Inoculation*, or the transplanting of turf, is another mode by which some tillage lands are laid down to permanent pasture: it is best adapted to such light soils as are not naturally of a grassy nature, as when the soil has been well cleaned of its weeds during a whole summer fallow and nicely prepared to receive the turf (which should be cut from good clean pasture lands), the grasses and their roots, being ready formed on a good soil, will stand a better chance of success, as they also receive a considerable proportion of their food from the atmosphere. When turf from inferior pastures is selected for this operation, it rarely answers; it would be far better to sow the land down with mixed seeds, suitable to the soil, than to run the risk of a failure. The autumn is the season preferred for transplanting turf. The tillage is by that period properly prepared and the moist season better adapted to the cutting and planting of the turf, and

sufficient time is allowed for establishing the roots previous to the dry or hot weather setting in. The process is certainly rather tedious, though it is simple when understood. The arable land having been beautifully prepared and made even, the turf is then supplied from the selected pasture, which, if intended for future arable culture, is all removed by the operation of a common paring plough at the depth of about $2\frac{1}{2}$ inches, and about 8 inches wide; it is then (by various means) cut into pieces of about 3 or 4 inches square, and planted from 6 to 9 inches apart, according to the quality of the soil. Care is taken to plant the grassy side uppermost and to press it well into the ground: it is a good system to place the foot upon it in due succession, taking care to have no more turf cut each day than can be planted before night. If the transplanted turf be deficient in any one or more favourite grasses, they should be sown over the new pasture in April. Particular attention is required in rolling these pastures at proper intervals, and when the ground is in proper temper (between wet and dry), which will cause the plants to extend themselves along the surface rather than to rise in tufts, as otherwise they would be apt to do. No stock should be placed upon them until they have shed their seeds; indeed, the pasturing should be very moderate until the mother grass plants and their young progeny have united and formed a compact turf. It is found that 1 acre of pasture land, prepared upon the plan previously named, will inoculate 9 of arable if judiciously performed. The expense of the operation alone is about 50*s.* per statute acre. Should the field whence the turf has been taken be required to remain in permanent pasture, only a portion of the turf is removed in shreds by the plough, leaving a sufficiency of turf for again uniting to form a perfect sward or pasture. Some adopt the plan of improving old pasture lands by giving them a dressing of compost during the spring months, and then dibble in a few tares, and at the same time sow a small quantity of mixed clover and grass seeds, by which means the sheep in feeding off the tares fasten the young grasses, and the pasture becomes renewed and improved.

The plan of partially inoculating old grass lands is practised by some, and to good effect: the process is performed by raising the natural turf, and inserting other selected turf from the best lands, which may be performed to any extent according to local circumstances.

The *meadow* ground, or that portion of the grass lands usually under hay culture, differs materially in its management, and is very varied in its character, as regards soil, situation, and local habits, and claims to be treated under their separate heads, viz. the meadow, the upland meadow, and the water meadow. In nearly every district, by far the greater proportion of the perennial

grass lands is the work of nature, and it is only of recent date that much attention has been paid to their management. But since the improved state of agriculture and the breeding and rearing of cattle have become general, their winter food has become in request and valuable; hence the study to increase it by artificial herbage on the arable lands, and by the improved management of the spontaneous productions of the grass or meadow lands.

Upon farms of any size it is customary to select a suitable portion of the occupation for meadow lands, which are kept under grass for the purpose of affording the necessary supply of hay, but are depastured at other seasons of the year, according to the occupation: those fields selected for meadow lands are usually more moist or cool in their character than those reserved for permanent pasture, as they are found to produce more hay and throw up a greater amount of edish or after-grass.

The meadows that are naturally well situated in the bottoms of valleys, or adjoining watercourses, are considered by far the most valuable, and are eagerly sought after; hence, in taking a farm, the general question—" Are there any good meadows?"

They produce an abundance of hay, which is usually carried off to the homestead, and adds materially to the general source of manure for other lands; while, from their soil being deep, and commonly alluvial, (owing to the great deposit of sediment left by the water passing over them, or washed down upon them from the adjoining eminences,) they require no return in the shape of manure. Care should be taken, however, not to allow the stream to pass over them at too late a period, if it can be possibly avoided; to clear them of all superfluous aquatics, to check the springs frequently arising at the hill sides, to keep open a regular supply of grips or watercourses for the quick clearance of the water when required, and that the whole cleaning up, mowing, and pasturing be so adjusted, as to keep the meadows in a good and profitable state without the aid of manure.

The *upland* meadows are various in their character, being selected or formed according to the varied localities: the soil of some is exceedingly good, while others are mown from an impression that they are but of little value, and therefore cannot be worse. The culture of these meadows is necessarily more expensive than that of the valleys, as they require much attention and regular supplies of manure, according to their character. The better soils are kept up to a regular standard of production by the constant manurings or top-dressings they receive, which form at length a thin black stratum among the roots of the grass, and become certain in their annual supply of nutritive produce. The irregular surface of upland meadows is apt to contain springs, which require attention, while other fields of a lower level require careful draining throughout to

eradicate the coarser grasses. Moss is a very common enemy to the dry upland meadows; it is checked by harrowing and by a good supply of manure, the one process obstructing the onward progress of the moss, the other stimulating the grasses to overcome or suffocate their enemy. It is most known upon poor soils, but rarely upon rich pastures. Rolling, and top-dressings of lime and salt, are frequently used for destroying it. Ant-hills occur more upon these soils than upon others, though they are quickly checked by throwing, or gelding, if operated upon in time. On those fields which are most subject to them, the heavy iron roller should be run over them at least once a year: rolling, however, may be carried too far, and the surface-soil become as it were set or hide-bound; in such case harrowing is adopted with success, particularly when applied previous to a manuring.

In the midland counties, upon such farms as have only a small proportion of arable land, it is the practice to eat the hay upon the land (or adjacent fields) where it grew: in such cases, we find on retentive soils, that when depastured with cattle or horses in wet seasons, the grass receives much injury from their feet, and becomes what is usually termed poached. Thus, when filled with water, the herbage is destroyed, and the ground becomes chilled and injured around it. Hence it is desirable to allow such meadows to remain until the dry spring months set in, before their produce is consumed. Excess of rolling upon such soils, when in a wet or moist state, produces similar effects, but of course in another shape.

The manures or dressings applied to the upland meadows are various, both in regard to their qualities and time of application. Upon this subject a diversity of opinion prevails amongst even the best managers. In the neighbourhood of large towns the dressings are usually laid on about Michaelmas, while the land is sufficiently dry to carry the carts, and when, as they have it, the season has so far advanced as not to exhale the volatile parts of the dung.

Some prefer its application directly after mowing, which is said to be the "good old time;" while others lay it on at times when the meadows are closed for hay, and when they can best be spared. I believe either plan to be good, provided the meadows get a good dressing once a year. Well-rotted dung or compost is preferred. In some districts it is the practice to mow two fields alternately, by which means parties state that the one year's depasturing or eatage sufficiently recovers the land for mowing again the following year without the aid of manure.

*Water-meadows* are those artificially formed for the purpose of irrigation: by this means many hitherto neglected districts have become exceedingly valuable; they serve as the key of dependence to whole occupations when once formed. The first outlay

in their formation is the difficulty,—it being found too formidable for the yearly tenant; and in many instances the landlords object also to what they term an unnecessary expenditure; they are more commonly performed by occupiers under long leases, or by arrangement for the owners to receive an increased rent or per centage for the capital so invested. The modern and truly valuable water-meadows are found on the estate of the Duke of Portland at Clipstone Park, Notts, which are so ably described by Mr. Denison in the first volume of the Society's Journal. In fact, parties desirous to lay out new, or improve old water-meadows should visit these in order to become well grounded in their general management, as also to witness their real value.

The watering of meadows for the purpose of promoting vegetation was among the pursuits of the ancient cultivators of the then existing pasture lands. We find on record the following opinion of Cato—" As much as in your power make water-meadows;" and Columella says—" Land that is naturally rich and in good heart does not need to have water set over it, because the hay produced in a juicy soil is better than that excited by water; yet when the poverty of a soil requires it, however, water may be set over it." Again, from the observations of other authors, it is fair to infer that water-meadows were numerous in former ages, from the want of good herbage for their cattle; while since the increased practice of sowing artificial grasses, and the general improved culture, they have apparently been less in demand. It is important to notice, that even the coarser herbage of boggy meadows is by this process improved, as also that those of the cold and meagre soils are accelerated and increased by it, or supplanted by a verdant surface of improved grasses. Eventually, as improvements roll on in the other branches of agriculture, the forming of water-meadows must become a subject of importance, particularly when considered in connection with the breeding and feeding of stock, which must ere long from necessity (as the population of this country increases) become more universal. It is consequently essential that there should be a bountiful and cheap supply of grasses of varied characters to meet the exigencies of the age.

The soils best calculated for water-meadows are those of a gravelly friable nature, as the effect is immediate and more powerful than upon any other descriptions of soil. Those soils which produce the coarser grasses require considerably more water to effect a change in their character than the former, as a stream capable of watering fifteen or twenty acres of light dry land would be found far too small for even half the quantity of cold clayey ground abounding in coarser grasses: it is, in fact, desirable to form a body of water for the purpose of floating these soils

to produce much benefit. Yet there are only a few soils to which irrigation may not be advantageously applied. Care should be taken to have the wet soils properly under-drained before the process of irrigation takes place, and that they be laid perfectly dry of the surface water when the business of floating terminates. The season for floating is that of winter, and not summer, as parties unacquainted with the process have too frequently supposed. The lands that permit of the greatest return are such as lie in low situations, on the borders of brooks, streams, rivers, or in sloping directions on the hill sides. The advantages to be derived from watering lands must, in a material degree, depend on the climate: most grasses vegetate in a temperature of 33 or 34 degrees. Still, as the most luxuriant pastures in every clime are those found upon lands naturally watered, it is best to imitate nature in cold as well as in warm countries. Land, when once improved by irrigation, is placed in a state of perpetual fertility without the aid of manure or any other material expense. In fact it becomes so productive as to yield by far the largest bulk of hay, besides affording an abundance of support to the ewes and lambs in the vacant spring months, and a liberal supply of aftergrass for the cattle in the autumn months. This is, in fact, furnishing extra food for animals, and converting it into manure to be supplied to other lands, thus augmenting in a compound degree that great source of fertility—manure.

So varied are the opinions of scientific men as to the qualities of the different waters most applicable to this purpose, that it would ill become me to offer an opinion relative to the chemical properties most beneficial; yet from experience I draw the conclusion that those waters which contain the greatest amount of food for the grasses must be the best; hence irrigation by liquid manure, or the sewerage of large towns, must be vastly more beneficial than waters free from all kind of impurity. This question is worthy of great consideration, by which means crops of grass would follow each other throughout the season, and be productive of immense results.

The expense of irrigation varies according to the situation of the land or nature of the work to be performed. Where the *catch* meadow system can be adopted, the expense is moderate, much less water is required, and in some situations the plan answers as well as flat-flooding. The expense of bed-work, &c., in the formation of the other system, varies very considerably: in some instances the outlay is enormous. Some persons object to irrigation from an idea that it makes a neighbourhood unhealthy; but as the water is continually kept in motion, the supposition is unfounded. It is also stated that though the produce may be increased, it becomes in a few years of so coarse a nature that

cattle refuse to eat it. Now this complaint cannot be applicable to those meadows which have been skilfully prepared and properly managed. When rushes or aquatic plants make their appearance, it is a sure sign that the meadow lies too flat, or that it is not sufficiently under-drained.

The detail of all the minor arrangements, or general process of irrigation, would prove far too long, and possibly too tedious, a subject to occupy more space in this essay.

*Warping* in moderation is carried out with success upon some grass lands, but it is most commonly adopted upon arable lands; in either case it can be only successfully carried out upon those lands which approach the borders of large rivers into which the sea tide flows, or where floods containing alluvial matter in a state of suspension are frequent. The effect of warping is widely different in practice to that of irrigation. In the latter case the improvement is effected by water; while that of warping is effected by a deposit of mud, or by the soil being increased. The season for warping is during the latter summer months, usually commencing at the end of July. This season of the year is preferred, as the land returns quicker to its former dryness, and besides the tides are less mixed with fresh water, and are consequently found more effectual in their deposit.

*Hay-making* (in connexion with the meadow lands) forms rather an important feature, and is attended with much anxiety, as no crop is more tedious to harvest, or repays better the extra care or pains bestowed upon it. It is admitted, and daily seen in practice during the season, that the further you travel southward, the better and more early you find the operations of hay-making, whereas the further you travel northward, or into the cooler districts, the less attention is paid to it: this is perceptible to the stranger as he travels through the country from one extremity to the other.

The making of hay has certainly for a length of time been carried to great perfection in the south, more particularly in the neighbourhood of London, as their harvest depends upon the well securing of their hay and clover crop. Previous to the introduction of the "hay-maker," their established process was to perform every operation by manual labour. When the season has really well commenced, a calculation is made as to the required number of hands to carry on every department effectually, each person being provided, according to a commendable practice, with his own implements. The best or more accustomed mowers are selected for this operation, in proportion to the grass to be mown: the remaining forces are adjusted according to their strength or merit to suit the various occupations; and all are expected to retain their allotted stations during the season. The mowers

perform their task by the acre; the hay-makers are usually paid by the day. In forming a calculation of the required hands, it is found that an average of five (boys, women, and men) to each mower is a proper proportion, and that the work progresses in a corresponding ratio, provided the weather permits.

*First day.*—The mowers having commenced in the early part of the morning, the grass mown before 9 o'clock is carefully "tedded" out over every portion of the ground, and if time allow it is moved again previous to 1 o'clock; after this it is "hacked" into small rows, the hay-makers following each other; when this is accomplished, they return to the early part, and place it in small "grass cocks."

*Second day.*—The first operation of the morning is the "tedding" of all the grass mown after 9 o'clock the first day, and that mown previously to nine on the second day; after which the next stage is to shake out the "grass cocks" (made the previous day) into small rows, or, in some instances, into round patches; in either case the spare ground is kept raked, and the hay moved once or twice previously to dinner-time, the early process adopted on the first day being also carried on in due succession. After dinner the more forward hay is raked into small double "winrows," then the next stage or portion is advanced as on the first day by "hacking;" after which the hay-makers return to the forward hay, and place it in moderate cocks, again returning to the "hacks," and leaving them as before in small "grass cocks."

*Third day.*—The process of "tedding" again takes place in the early part of the morning, and every other order, as practised on the two preceding days, follows in proper and due succession; the hay most forward now requires nice attention, and is managed according to the appearance of the weather; if fine and warm, it is again shaken out into round patches, or, if a heavy crop, is usually strewed into "winrows," and again moved over previous to dinner or 1 o'clock: after this arrangements are made for carrying—a period of much anxiety. As every operation to be performed in due succession is now in full practice, and considerable judgment is required to keep all hands going on at a proper and profitable rate, a man of energy will realize the old adage, and "make hay while the sun shines;" should the weather prove cloudy, or otherwise, the principal attention and time is necessary to secure those portions under the later processes or stages.

*Fourth Day.*—Nothing fresh occurs on this or the succeeding days beyond the plans carried out on the third day; in fact, at this stage of the proceedings every movement is in accordance with the appearance of the weather. Care is taken to keep the hay in cock, or near together; the land is well raked, and there should be by no means a preponderance of mowers, for it is very

unwise to have more hay down at any one period than can be managed upon the established process. Since the introduction of the hay-maker this implement has partially superseded manual labour, and supplied the place of a considerable number of hands: it expedites the work in a remarkable degree, and at some periods of the hay season is almost invaluable.

Nevertheless, great care is required in using the hay-maker in wet or damp seasons, the hay being found to injure more rapidly after it has been opened to that remarkable degree attained by this simple yet efficient implement. The hay-stacks in the Metropolitan district are neatly formed, trimmed, and finished by thatching, which is quickly accomplished after the ricks are completed. The more general process of hay-making, as we gradually approach northward, is of a less attentive order, arising either from a want of system or of a proper number of hands, or from an apparent desire to get in the hay cheap: this may possibly arise from the absence of the southern stimulant—a good market. The general practice is to consume it upon the farm. Their early management is to allow the grass to remain two or three days before it is touched; it is then turned over in the "swarth," and the following day it is thrown into "win-rows," and possibly cocked up at night, as time may allow; it is then carried next day, which completes the apparently cheap system: after which it frequently happens that the stacks are raked down and remain until a leisure time occurs (in some instances until after harvest) for completing and thatching. Thus, in the northern districts, abundance is actually the bane of attention.

The cheapest way to get hay, and to insure the greatest value out again, is to harvest it quick by a sufficiency of labour, and not to allow it to be made by the sun at the risk of every cloud. Such hay-makers rarely or never have good weather for their hay-time, but are more general in the use of salt as a sweetener of their hay, by the aid of which, it is stated, the cattle relish even their worst hay. It is rare, however, that we hear of its use among the best hay-makers, it being their pride not to require it.

The consumption of after-grass varies but slightly (with the exception of its being occasionally mown a second time for hay) in the neighbourhood of London and other populous towns; it is generally fed off on firm dry lands by cattle, after it has been reserved for them for a few weeks. The cattle are succeeded by sheep and other store cattle. This is also the practice on many of the upland meadows, while some occupiers prefer to stock them directly after the scythe with sheep and young beasts; by this means they more quickly establish a bottom to the pasture. In such case these parties generally lay on their manure or compost at this season—a second certain aid in advance of the pasture

effecting a speedy recovery after mowing: in the former case all chance of seeing the bottom-grass is given up until the succeeding spring, when, if again mown, it adds to the accumulating injury sustained; and these meadows eventually become worn out by mowing, and consequently much reduced in value. Hence it follows that lands are better when mown alternately with others, as they recover themselves during the year they are depastured, and then require less manure. It is quite certain (the result of practice) that all lands which have been mown require extra close feeding to subdue the stubble formed by mowing, and to cause the natural grasses to resume their former habit. The after-grass upon the cool or marshy meadows is widely different from the upland meadows, as their produce is of a coarse character, and not to be injured by mowing, but rather accelerated; yet if not eaten down, as required by the former, the grasses gradually get sour and coarser in their herbage. Close feeding at least once a year is essential to all grasses.

The *eradication of weeds,* such as the common thistle, the large or spud thistle, nettles, rushes, hassocks, and moss, is a point deserving much attention.

In cleaning land of the common thistle, which abounds to excess in some localities, one of two certain modes is adopted by the best managers, according to the custom of the country. One plan is to have them drawn or pulled up by the roots twice a-year (the first time of going over them being about the end of May, the second time either just before harvest or directly after, according to local circumstances); the other plan is to spud or hoe them up below the knot or first joint of the thistle; by this means each thistle is destroyed. The time of performing this work is the same in both cases as that of drawing them.

Where disappointment occurs after spudding or hoeing, it is in consequence of the work of eradication not being done properly. Those thistles which have been cut off *above* the knot throw up an increased number of fresh shoots, while those cut below are certain to decay. Some farmers think it best to allow the thistles to remain until they are ready to flower, they are then mown and raked up and carried away; this, however, is by no means an example for good and clean husbandry, though it is argued that by this process the water gets into the crown of the thistle that remains, and it is thus destroyed.

On meadow lands which are annually mown it is a rare occurrence to find a thistle: this would apparently go to support the previous plan of allowing them to be full grown before mown. Yet in practice, where the plan is adopted on pasture lands we find them far from free, indeed but little changed, while the two former plans certainly effect a clearance.

The large or common spud-thistle is best eradicated by what is termed a "thistle-drawer"—an implement formed like the two first fingers, resting upon a round projection in the shape of the back of the hand, which is placed in a shaft of moderate length: the two leading prongs are placed on either side the thistle, and by a gentle wrench the thistle is removed entire from the ground. This may be done at such period as they may show themselves sufficiently large to be removed. These thistles may also be removed by placing a drop of sulphuric acid upon the crown.

Nettles are found most upon the rich or better pasture lands, and from their peculiar or determined growth are exceedingly troublesome to eradicate. The common practice is to knock them with a fork as they appear above the pastures, or to mow them at different periods, but neither plan is found to reduce them with any degree of certainty. The application of agricultural salt to them, at different periods of the season, has in many instances succeeded in removing them. Some persons raise the ground with a fork and draw out the roots, which practice, if closely followed up through a few seasons, is certainly effective. The appearance of this weed upon pasture lands is considered a sure indication that they are improving, or are already rich soils, as they are rarely found growing upon inferior pastures.

*Rushes* are indigenous to wet soils, and are the certain guide to moist situations. They are to be removed by deep and effectual draining only, whereby the food of this aquatic plant is suspended or carried away: hence they are supplanted by modern grasses in due proportion to the change that has been effected in the character of the soil.

*Hassocks* may also be described as the production of cold or wet lands, for they are rarely found upon dry pastures, unless such pastures have recently been drained.

When they casually appear upon grass lands, they are removed by what is termed a "hassock-hoe," which takes them off just below the root, without making a deep hole in the surface, when well performed; they are then removed and burned for ashes, to be taken to the arable land, and the then vacant spots are sown with grass-seeds. When they appear to a considerable amount, which is too frequently the case in the midland counties, they are removed by this process in immense quantities, and carted into a heap, there to decay, and, being afterwards mixed with lime to form a compost, are again returned to the soil. They are also successfully removed by a short scythe, which is kept exceedingly sharp for the purpose; in such case the party applies the implement as near the bottom of the "hassock" as circumstances will permit, which is accomplished by a quick and determined stroke: by attention to a repetition of this plan they are effectually

removed without disturbing the soil; the new grasses gradually close upon them, and eventually supersede them.

Some pastures, from being long neglected, become a mass of hassocks, as, from their strong coarse growth, no other grasses can endure or live with them upon these cold and neglected soils. In the improvement or redemption of these pastures it is usual to commence with draining of various depths, according to fancy; but in every instance we find them left even in a more difficult state when the water has been removed, as the pasture then assumes the character more of a stubble field than otherwise. Hence the local term, "this land has been over-drained;" which is true, as regards the then or former aquatic grasses inhabiting these soils, for they are left in a state of destitution, though they receive a sufficient support from the changed soil to linger on in their occupation, to the prejudice and exclusion of the new race of modern grasses, which it is intended should occupy their place. Close feeding with cattle and horses, and a plentiful supply of artificial manures to sweeten and increase the new herbage, is the surer way to effect the change. Yet some consider it the better plan to plough up such pastures, and, if required to be under grass, to renew them after one or two years' arable culture.

*Moss* is exceedingly troublesome upon some soils, particularly those of an inferior character; no plan is found so good as to harrow the pastures freely and frequently, and give them a good dressing of compost, for which purpose the following mixture has been found of great value, viz. 20 bushels of salt to 40 bushels of lime is sufficient for one acre, and may be prepared in the following order:—1st. Place lime 6 inches thick, then place a layer of salt 2 inches thick upon it, repeat this plan three times, or until it reaches the height of 2 feet; then turn and mix it, and repeat the process at intervals of ten days for at least three times, when it will be ready for use, and may be applied either early in the spring, or at the close of the year; the above compost is valuable for any agricultural purpose, and is found to suit grass lands exceedingly well.

*Ant-hills* in some parts of the midland counties are both numerous and troublesome; there are two plans in practice for removing or destroying them—one is, to cut them entirely up, upon a level with the remainder of the pasture, and cart them into a heap to form a compost to be mixed with lime, and again returned in that shape to the pastures; the other plan is, to throw them, or what is provincially termed "gelding;" in such case a proper implement is provided for paring off the hill sides quite thin, which are rolled over in suitable pieces to the bottom, where they remain until the interior soil has been thrown out over the neighbouring clear land, when the grass is again returned, and

arranged to supply the place of the previous hill; the soil thrown out is knocked at intervals, and eventually reduced by the bush harrow, and covered by the neighbouring grasses.

An exceedingly heavy roller is then passed over that portion of the field which has been under improvement, it being usual with the best graziers to remove a certain quantity every season. November is considered the best month for this operation, as the insects are then exposed to the winter elements, and the soil thrown out is more certain to be pulverized.

The *fences* upon grass lands form an important branch in their management: they are numerous and varied in their character, each district having its own style of fence or particular method of management. Upon the old enclosed grass lands in the midland counties are found troublesome hedges, many of which have stood the "test of ages;" but are now exceedingly thin or gappy, and are only made secure by post and rail fencing being placed in them where required; such fences, as also the more modern ones, have a protecting ditch on the outer side of the property, which in many cases decides whom the fence belongs to, when the occupations of two parties under the same landlord approach each other.

The management of these hedges is simply to keep laying them down in the thin or weak places, or to lay them as rough as possible against the attack of the oxen depastured on the land. Upon the more recently enclosed pasture lands, the fences are found much better, and are usually managed by the common practice of laying them in a strong manner, care being taken to reverse the side to which they were inclined in the preceding cutting, the dike being cleansed at the same period.

In the formation of these fences, it has been customary to plant two rows of quick upon a moderate bank of earth, formed by the surplus soil thrown up from the ditch. In the after management, when full grown, it is usual to cut off one row entire, and form the fence or protecting hedge of the other; they are thus kept in a fruitful state: when cut the next time, they are reversed.

In many parts of Leicestershire it is the custom to place a single post and rail on the one side, and to keep the ditch well cleansed on the other.

The pastures in the marshland or lowland districts of the country are chiefly bounded by dikes from 10 to 12 feet wide, or by drains acting as public water-courses; in either case it not only gives the country a cold and vacant appearance, but is found exceedingly bleak for cattle, particularly when first removed to the early pastures in the spring months. In those districts situated near to large rivers or outfalls, the practice of taking in fresh water upon the farm is an invaluable one during the summer months, grips being made in various directions on the

grass lands to admit of the water standing nearly level with the surface, which is preferable to irrigation at that season of the year.

Few cattle, however, are depastured upon these lands during the winter months; in some instances they are supplied with a stubble or straw stack, for the purpose of shelter. Where quick fences do occur in these districts, they are of a splendid character, being exceedingly thick and strong, and requiring no other attention than being kept within bounds. In some districts the plan is adopted of cleansing the hedge-bottoms and siding them up—thereby forming an efficient shelter for cattle during the cold months: these, when properly attended to, become very thick and matted, and are maintained at an easy rate. When gaps or thin places occur, they are stopped with suitable pales in place of the old plan of post and rails; this plan effects a saving of much land, and an excellent and certain shelter is provided for the stock—an important point in their management.

With regard to the dead fencing upon grass lands, such as gates, bullock and sheep pens, post and railing, &c., it is best in every case to place down good and seasoned wood, taking care that the new material shall be placed all together, and to mend with the inferior or surplus wood. When this system is adopted it is advantageous to apply paint of a cheap yet durable character to the gates and other fencing which may seem to require it, or will repay the outlay.

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## II.—*A Lecture on the Anatomy, Physiology, and Pathology of the Digestive Organs of the Ox and Sheep.* By James B. Simonds, Lecturer on Cattle Pathology in the Royal Veterinary College, London.

My Lords and Gentlemen,—At the request of the Council of your influential and patriotic Society, I have the honour to address you this evening on a subject which is closely identified with the prosperity of agriculture, namely, the diseases of cattle and sheep. In the observations which I shall make, it will be my endeavour to use plain and familiar language, and to avoid as much as possible technical terms. If, however, I fail to do this, and should need your indulgence, I venture to hope that it will not be withheld; for my daily avocations ill adapt me to employ popular expressions in describing either the structure of a part or the nature of a disease.

Cattle pathology, like every other division of medical science, is so extensive, that many lectures are necessary to explain its leading peculiarities; and it is almost impossible to condense into one

that amount of information which shall prove practically useful to those by whom this branch of medicine has never been investigated. In fact, great perseverance and research are required to understand the workings of Nature's laws, when any single organ becomes impaired. Hence those only who have by previous study made themselves conversant with the various tissues composing an animal body, are fitted to undertake the treatment of disease; and not only is this knowledge absolutely needful to secure success, but equally so is an acquaintance with the functions of the different organs. Anatomy supplies the one requisite, and physiology the other; while by a union of these sciences a basis is formed, upon which is raised the practice of pathology, or the skill of repairing any defects in either the structure or function of the frame.

It will, therefore, be easily understood that the selection of a subject best suited for the carrying out the wishes of your Council has been difficult; for I had to avoid discursiveness on the one side, and minuteness of detail on the other, and yet to speak of that which should be both interesting and instructive. After due consideration I have decided on confining my observations to that system of organs termed the digestive, and principally as developed in ruminating animals. With a view also to render my description better understood, I propose to divide the lecture into two sections, and first to explain the leading peculiarities of these viscera, and next, the nature of some of their diseases.

The supplying of animals with suitable food, the knowledge of the way in which it is appropriated to the wants of the system, and of the ill effects arising from impaired digestion, are of the first importance to those who devote their time and their money to the fattening and rearing of our domesticated breeds.

The process by which the aliment is converted into flesh and blood is similar in all animals of the highest order, but is modified by the habits of the creature and the character of the food on which he subsists. Digestion may be said to be the chief means employed by the great Creative power for the preservation of all beings; and upon it and assimilation health likewise mainly depends. For in proportion to the energy of digestion, so will be the purity of the blood—that fluid which carries, by its circulation through the heart, arteries, and veins, the elements of vitality, nutrition, and renovation to every part of the body. One organ, therefore, has a mutual dependence on another, and each is so adapted that it may perform its function in the best possible manner. We have evidence of this wisdom of design in the various arrangements of the bones of the head, and in the attachments of the jaws in different animals; and as digestion begins in the mouth, I shall first direct your attention to the peculiarities here met with.

The circumstance of some creatures living on food which others reject has influenced naturalists in placing them in different classes. Our domestic animals offer a sufficient illustration of this, as among them we find both vegetable and flesh eaters, and also those which partake of both these kinds of diet. The horse, ox, and sheep are graminivorous; the dog and cat carnivorous; but the pig is omnivorous. We may also state that in general the stomachs are complex in the herbivora; simple in the carnivora; and hold a middle position in the omnivora. Many other particulars besides the above-named govern the arrangement of animals in groups or families, but it is unnecessary to occupy your time with an account of them, as a reference to the table (p. 30) will show each subdivision. It must, however, be observed that a separation of animals into vertebrate and invertebrate is the first grand division made by zoologists. The former class includes all that possess a chain of bones (vertebræ) extending from the head and forming a cavity through which passes the spinal marrow, or a continuation of the brain: the invertebrata are without these bones. The second separation consists of those which are furnished with mammæ, or teats; and it will be evident that such animals bring forth their young alive—are viviparous, not oviparous: fishes and birds thus belong to another class. The mammalia are numerous, and may be said to inhabit the water, the earth, and the air, of which we have examples in the whale, the horse, and the bat. All of them are warm-blooded, breathe atmospheric air, and possess lungs for the purification of the blood.

To return to the chief subject of this discourse. It has already been stated that digestion commences in the mouth, where important changes are effected in the aliment. The way in which our different domesticated animals collect their food and convey it into this receptacle, first therefore demands our attention. The lips, tongue, and incisor teeth are the organs principally employed for that purpose, and consequently they are more or less prehensile in all. The horse, when feeding on natural herbage, grasps the blade with the lips, and by them it is conducted between the incisors, which he employs for the double purpose of holding and detaching the grass, the latter action being assisted by a twitch of the head. The sheep gathers his food in a similar manner, but he is enabled to bring his cutting teeth much nearer to the roots of the plants, in consequence of the upper lip being partially cleft. Hence the adage, that "the sheep will fatten where the ox will starve;" for the upper lip of this animal is thin, and possesses considerable mobility; while that of the ox is thick and hairless, and has a very limited action. The ox uses the tongue to collect his food. The organ, being protruded from the mouth, is so directed as to encircle a small bundle of grass, which

## ZOOLOGICAL ARRANGEMENT.

| DIVISION. | CLASS. | VARIETY. | FAMILY. | ORDER. | TRIBE. | GENUS. | SUB-GENUS. |
|---|---|---|---|---|---|---|---|
| VERTEBRATA | MAMMALIA | THE HORSE | UNGULATA | PACHYDERMATA | SOLIPEDA | EQUUS | EQUUS CABALLUS. |
| | | THE OX | UNGULATA | RUMINANTIA | BOVIDÆ | BOS | BOS TAURUS. |
| | | THE DOG | UNGUICULATA | CARNIVORA | DIGITIGRADA | CANIS | CANIS FAMILIARIS. |
| | | THE SHEEP | UNGULATA | RUMINANTIA | CAPRIDÆ | OVIS | OVIS ARIES. |
| | | THE PIG | UNGULATA | PACHYDERMATA | PECORA | SUS | SUS DOMESTICUS. |

is carried by it between the incisor teeth and an elastic pad placed opposite to them in the upper jaw—between these the herbage is pressed and partly cut asunder, its complete severance being effected by tearing. Most ruminants possess a great freedom of action in the tongue, of which we have a good illustration in the giraffe when browsing.

The aliment, being received into the mouth, is next conducted between the molar teeth, where it is subjected to a grinding process (mastication), during which it is also mixed with the fluid called saliva—in other words, it is insalivated. The action of the jaws in mastication differs even among vegetable feeders, arising from the peculiar attachment of the lower maxillary bone to the skull. This difference is most striking between ruminating and non-ruminating animals. In the ox, the mouth being slightly opened, the lower jaw is carried to one side, next elevated so as to approximate the surfaces of the molars, and then moved in the opposite direction, bruising the food between the teeth. This action, having commenced, is generally continued either from right to left or *vice versâ,* depending on the will of the animal. A separation of the jaws does not take place to the same extent in the horse, but the provender is comminuted by an alternate motion of the jaw from side to side. In the dog and the carnivora the lips are simply retractile, and the molar teeth are used for crushing only, there being no lateral action of the lower maxillary bone. The incisor teeth in this class may likewise be viewed as organs of prehension.

In the mammalia the teeth are situated in grooves formed in the bones which compose the mouth; in fishes they often occupy the upper part of the gullet, and are attached to the lining membrane of the oral cavity; and in the crustacea they are placed in the stomach. The gizzard of the fowl performs an analogous office to mastication in animals, its function being assisted by earthy matter which is swallowed by the bird.

We will add a few remarks on some of the leading peculiarities of the teeth. The incisors in the horse are twelve in number, arranged in two sets—six in the upper and six in the lower jaw—their faces, which are flattened, have an indentation (the mark), which affords evidence of the age of the animal. This hollow is surrounded by the central enamel, between which and the outer border of the tooth the dentine, or ivory, is exposed to attrition. The development of enamel in this situation tends to keep up an irregularity on the surface of the organ, by which its cutting property is preserved; for this substance possesses a far greater density than the other structures composing the tooth. The ox and sheep have eight incisors; they are situated in the lower jaw,

and differ altogether in their shape from those of the horse: viewed in front they present a sharp edge, from which they slope inwards and backwards, giving them a scoop-like form. The edge is formed by enamel, which covers the dentine; its greater hardness causes the tooth to retain its original shape for some time, but long-continued wear renders it more or less flat, a condition which is indicative of advanced age. The early-formed teeth are temporary and small; they give place to a permanent and larger set at the period of adultism, when all parts of the frame are matured. Many of the rodents are said to change their teeth several times: the hare and the rabbit belong to this class. Most ruminants are devoid of tushes; the camel and some of the deer tribe are, however, exceptions. The molars of the horse, ox, and sheep are twenty-four in number, arranged in sets of six on either side of each maxillary bone. Their composition and development are essentially the same, although they vary in size and form in each animal; it is, however, unnecessary to enter upon these details.

Mastication and insalivation are important processes in the digestive function, and any derangement of them is certain to be associated with impaired health. The saliva is furnished by a number of secreting organs (glands); the chief of these are the parotid, the submaxillary, and the sublingual, all of which are of large size in ruminants; besides which, in these animals we meet with a number of other glands, which receive the name of buccal, from being placed directly beneath the lining membrane of the mouth. Physiologists are divided in opinion with reference to them, some viewing them as salivary, and others as mucous glands.

The quantity of saliva which is secreted is very considerable, and several pints may be obtained in the course of a few hours from even one of the parotids. The action of this fluid on the aliment is twofold—chemical and mechanical; by the first the food is rendered alkaline, and by the second soft and pulpy. The saliva is also viscid—a condition that depends on its being commingled with mucus, which is secreted by glandular structures that thickly stud the parietes of the oral cavity. We can only allude to the viscosity of the saliva, which serves, according to Liebig, an important use in the animal economy, by conveying oxygen, in the form of atmospheric air, into the stomach. The figure on the following page will explain the salivary apparatus.

In the ox and sheep the food undergoes but little preparation when first taken in, being quickly conveyed through the œsophagus (gullet) to the rumen, from whence it is subsequently returned for a second mastication. Deglutition or swallowing is a compound act, and may be divided into three distinct stages:

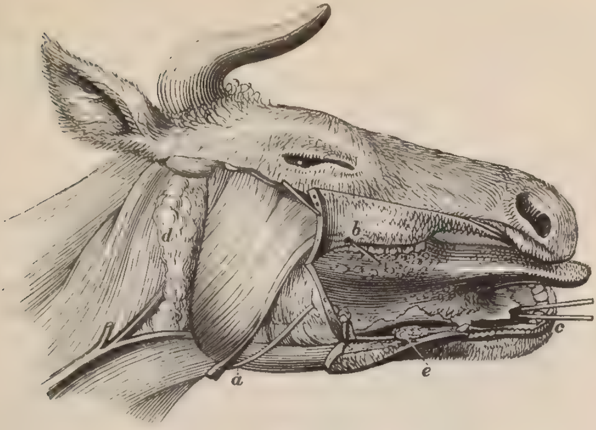


Fig. 1.

*a*, The Parotid Duct. *b*, Its Opening into the Mouth.
*c*, The Entrances of the Submaxillary Ducts. *d*, The Parotid Gland.
*e*, The Sublingual Glands.

the first of these is voluntary, the second but partly so, and the third altogether involuntary; the first conveys the food from the tip to the dorsum of the tongue, the second from thence to the pharynx placed at the upper part of the gullet, and the third from this to the stomach. The velum palati, or veil which guards the openings of the nostrils at the back part of the mouth, is large in the horse, and so situated as to direct the current of air, in ordinary respiration, through the nostrils. An equal development of this structure in the ox or sheep would interfere with the return of the ingesta from the pharynx in rumination, and consequently in them the veil is of smaller size, and takes a somewhat altered course; hence these animals are enabled to breathe both through the mouth and nostrils.

The entrance to the œsophagus is by the pharynx, which is defined by anatomists to be a funnel-shaped receptacle for the food, composed of several pairs of muscles, and lined by a continuation of the membrane of the mouth. The œsophagus may be viewed as a canal extending from the mouth to the stomach; being also constituted of muscular fibres, and lined with a mucous membrane. These fibres possess an action independent of the will, as is the case with all muscles belonging to organic life. Their arrangement varies in different classes of animals; but we shall speak principally of it as observed in ruminants. The œsophageal tube has a loose cellular connection to the parts by which it is surrounded, so as to allow of its dilatation in the acts of deglutition and rumination. The muscular coat is composed

of two orders of fibres, which partly decussate on each side of

the canal, the internal layer thus becoming the external, and *vice versâ;* their leading arrangement may, however, be compared to two circular-shaped bands placed obliquely, the one within the other, by which an equal facility is given to their action when commencing at either extremity. In its course down the neck, the œsophagus is situated more above the trachea than in the horse, it passes between the two first ribs, traverses the upper part of the chest, penetrates an opening in the diaphragm (midriff) termed the foramen sinistrum, and enters the anterior and superior portion of the rumen. At the lower end of the tube the outer order of muscular fibres is found to take a direction nearly parallel with its course, and to be reflected upon the rumen, blending with the external muscular layer of that viscus. (See *a, fig.* 4.) The mucous lining membrane, to which we have before referred, lies in longitudinal plaits in a passive state of the œosphagus ; an arrangement which allows of its being extended in the ascent or descent of the ingesta, for it is very loosely joined to the muscular coat. Between these two coats a considerable quantity of elastic tissue exists, which throws the membrane into the above-named folds after being upon the stretch, for of itself it is devoid of contractility and elasticity.

We proceed to a description of the stomachs. The size, shape, entrance into, and passage out of the stomach are modified according to the nature of the food and the habits of the animal. As before observed, the organ possesses its simplest form in the carnivora, and its most complicated in the ruminantia. In vegetable feeders it is always more complex than in those animals that subsist on flesh, as a necessity exists for the aliment to be detained within it for a greater length of time. We have good evidence of this by comparing the stomach of the dog with that of the horse; in the former, the openings leading to and from the cavity are far removed, while in the latter they are situated close to each other; hence the ingesta has to travel nearly to the place where it entered before it can escape. This causes a longer retention and a more complete action of the gastric juice upon the ingesta, to prepare it for conversion into blood. In omnivorous animals, as the pig, the stomach is imperfectly divided into two or more compartments or pouches, an arrangement which allows certain qualities of food to be kept within it for a longer period. We should also mention, that in the omnivora the mucous membrane of the œsophagus lines a small portion of the cardiac orifice of the organ; in the carnivora it ends immediately at the entrance of the tube; but *even in the simple-stomached* herbivora

it extends over a large part of the cavity: the cause of this is evident when we look to the nature of the food on which these several animals subsist.

Our domestic ruminants offer a still more interesting field for

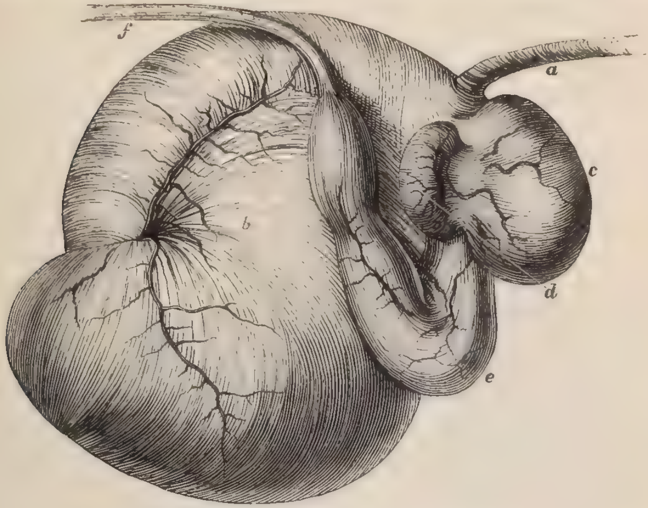


Fig. 2, Right View.

*a*, The Œsophagus. *b*, The Rumen. *c*, The Reticulum. *d*, The Omasum. *e*, The Abomasum. *f*, The Duodenum.


Fig. 3, Left View.

The references are the same; the Omasum is not seen.

investigation, as in them we find four distinct stomachs or receptacles for the aliment; of these one only is the true digestive organ. The names given to them are, *the rumen* (paunch), *the reticulum* (honeycomb), *the omasum* (manyfolds), and *the abomasum* (rennet): figures 2 and 3 represent the right and left view of the stomachs of the sheep, as seen *in situ*. The rumen is by far the largest of these viscera; it inclines to the left side, and occupies a considerable portion of the abdominal cavity, extending from the diaphragm in front to the pelvis behind. Like the other stomachs, it has three tunics or coats; the external being continuous with the ordinary serous lining of the abdomen: beneath this is placed the muscular coat, and on the inner surface the mucous, which is covered by a thick epithelium. The muscular coat is thicker in some parts than in others, and its fibres are crossed by strong fleshy bands, which divide the viscus into four pouches. The accompanying figure of the external view of the rumen of the ox, as seen on the right side, where the bands are chiefly developed, shows the divisions; they are, however, better delineated in the subjoined sketch of the interior of the rumen and reticulum. The compartments serve for the retention of the food, which is thereby softened by exposure to the secretion of the organ; they also perform other important offices, which will be presently explained. The membrane which lines them is more or less papillated throughout, but particularly at the inferior part of each pouch; the bands, however, have comparatively

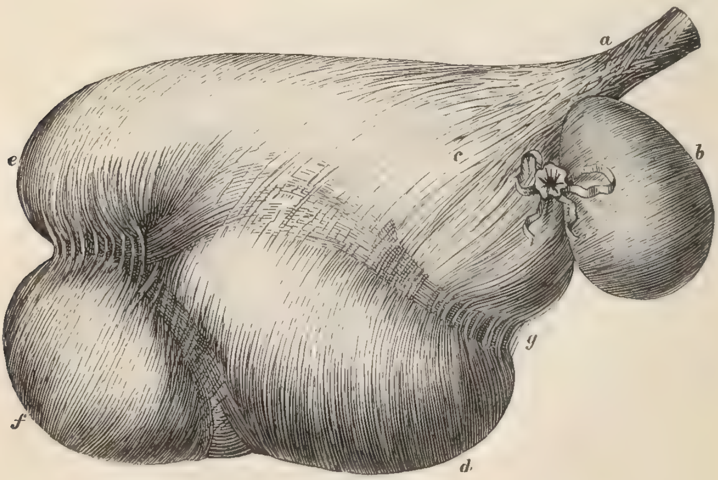


Fig. 4.

c, The Anterior Pouch. *d*, The Middle. *e*, The Postero-Superior. *f*, The Postero-Inferior.

a smooth surface, so that no additional mechanical impediment should interfere with the ready passage of the aliment from one pouch to the other. The function of the rumen will be better understood when the peculiarities of the reticulum have been pointed out. This viscus receives its name from the net-like structure of its mucous membrane. It is attached to the anterior part of the rumen, on the left side, and lies directly under the termination of the œsophagus. Its muscular coat is composed of two orders of fibres, the outer being arranged in a circular and the inner in a longitudinal direction, by which means the viscus is capable of being generally compressed. On exposing its interior, by cutting away the left side while *in situ,* two fleshy bands

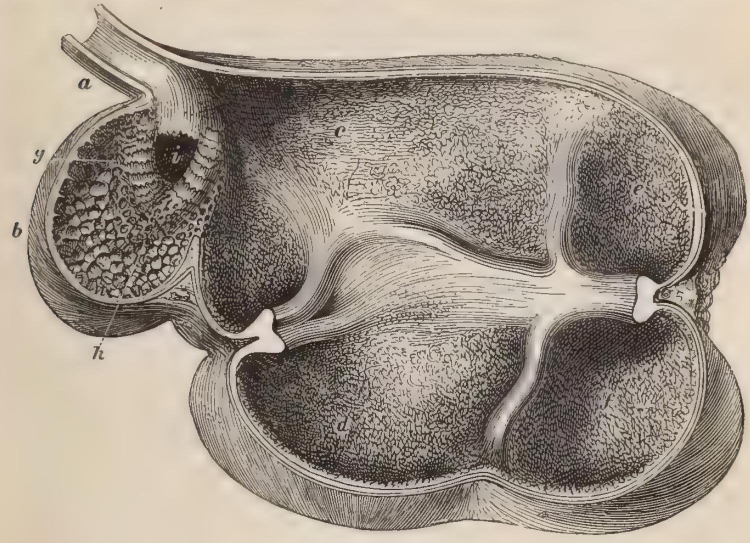


Fig. 5.
The Rumen and Reticulum laid open by removing the left side, while *in situ.*
*a,* The Œsophagus. *b,* The Reticulum. *c,* The Anterior Pouch of the Rumen.
*d,* The Middle. *e,* The Postero-Superior; *f,* The Postero-Inferior, Compartments.
*g* and *h,* The Pillars of the Œsophageal Canal. *i,* The Entrance to the Omasum.

are seen leading from the termination of the œsophagus and winding through the cavity towards an opening which communicates with the omasum. These bands or pillars constitute the lateral boundaries of the œsophageal canal. (See *g* and *h,* fig. 5.) The muscular fibres of which they are formed run parallel with their course, and, when in action, they must tend to approximate the entrance into the omasum to the termination of the œsophagus. We proceed to make a few observations on the physiology of these two stomachs, it being generally admitted that they are chiefly employed in the act of rumination; although a difference of opi-

nion prevails as to the manner in which this is effected. We have previously remarked, that the food when first gathered is but slightly masticated. This crude food in being swallowed proceeds from the gullet direct into the anterior division of the rumen, without entering the œsophageal canal, as has been described by most authors. Pellet after pellet is swallowed until repletion of the paunch is produced, when rumination usually commences. The act of rumination, although under the control of the will, is partly excited by the nature of the aliment and the amount of the distention of the paunch: it may be said to consist of the passage of a portion of the ingesta up the œsophagus, its re-mastication and insalivation, together with its re-deglutition. The prevailing opinion is, that the food passes from the rumen into the reticulum, where it is moulded into a small ball, and by an energetic contraction of that viscus is forced into the œsophagus; and that in its second descent, "either being of a softer consistence, or not being so violently driven down the gullet, or by some instinctive influence, it passes *over the floor of the canal without separating the pillars*, and enters the manyplus, or third stomach."* We do not agree with these statements, and are of opinion *that the food in its second descent goes into the rumen; and also that it is propelled directly by this viscus into the gullet to be remasticated.* Thus we ascribe the same function to the rumen which is said to belong to the reticulum. The situation of the second stomach must interfere with its supposed property of propelling upwards the pellet, for it is placed nearly at a right angle with the course of that tube. This objection does not apply to the anterior division of the rumen, which we believe to be the part from whence the food is ejected. The muscular coat is thicker here than elsewhere, and its fibres are continuous, as before remarked, with those of the lower part of the œsophagus; besides which we find them implanted into a strong fleshy band, which crosses the viscus in such a direction that it serves as a fulcrum from which they can act. (See *g*, fig. 4.) Thus we see that even upon mechanical principles the rumen is adapted for this *special* purpose. If the *remasticated food* descended directly into the third stomach, we should expect to find that organ of a proportionate size to contain as much as would undergo the process during at least one rumination; for all authors agree that the food is detained for some time in the omasum, and it is well known that an ox will continue to ruminate for upwards of an hour. The omasum, however, in this animal, is far too small for such a purpose, and in the sheep it is relatively smaller. If also it be true that such aliment does not pass into the rumen, "because it is less irritating to the

* Youatt on Cattle, p. 432.

pillars of the canal," then *prepared* food, as soft mashes, &c., ought when *first* swallowed to enter the omasum, and fluids would also take the same course, whereas we have many proofs, afforded by experiments, that these find their way into the first and second stomachs. Besides which, the pillars do not form "the *floor* of the œsophageal canal,"* as stated by Mr. Youatt and others, but *the sides* of the channel: and *if they are placed in contact, then there is no passage or duct behind them:* in short, the errors of description have arisen from studying these structures on the dissecting-table alone, and not in their natural situation. Our opinion of rumination receives further confirmation from the fact that many ruminants, of which the camel is an example, do not possess a reticulum; therefore in such animals the rumen must propel the ingesta upwards. We could advance many other facts to negative the general belief, but it is unnecessary to do so on this occasion. It may be asked, what function we ascribe to the reticulum? We answer, that it supplies the third stomach with aliment suited for digestion; this it receives from the rumen by the ordinary peristaltic action that is continually going on in that viscus, and passes it at intervals through the aperture situated at the inferior part of the œsophageal canal. (See *i*, fig. 5.) And we are further of opinion, that the before-mentioned pillars perform an office analogous to a sphincter, by drawing the opening which communicates with the omasum towards the œsophagus, and thus close it against any coarse or indigestible matter that is presented by the reticulum.

The omasum is situated to the right of the paunch, and is the medium of communication between the second and the true digestive stomach. Its ordinary name, *manyfolds,* is given to it from the lining membrane being plicated. The plaits vary in length, and follow no definite arrangement with reference to the dimensions of those which are placed side by side: their number also differs in different animals; from 80 to 100 are usually found in the ox, but rarely more than 50 in the sheep. At the entrance next to the reticulum they spring from, or are condensed into, six or eight prominent ridges, which evidently divide the current of softened ingesta as it flows from that viscus, and thus disperse it between the multiplied folds.

The function of the omasum has been compared to the gizzard of the fowl, but improperly so in our opinion, for its muscular coat is so slightly developed that it is impossible for it to exert any triturating effect on the aliment; and the altered and varied condition of the contents of the stomach, as we believe, depends entirely on the amount of fluid secreted by it. A reference to

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* Cattle, p. 427.

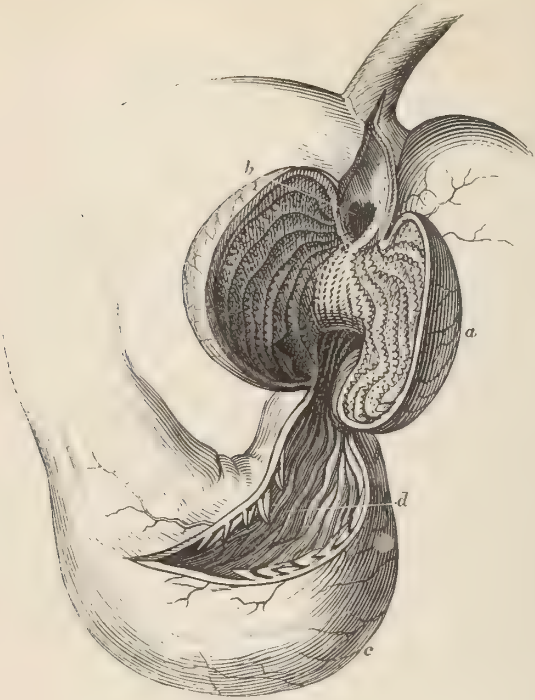


Fig. 6.

*a*, The Omasum, cut open to show its folds, &c.
*b*, The Opening communicating with the Reticulum. *c*, The Abomasum, or true Digestive Stomach.
*d*, The Villous Membrane of the Abomasum, which is also plicated.

fig. 7, representing the stomachs of the calf with the vessels injected, will show that the omasum, *b*, receives a large quantity of blood—much more than can possibly be required to maintain the integrity of its structure, and, consequently, this must be sent for the purpose of secretion. We therefore regard the function of the organ to be that of effecting the retention of the food by its mechanism, so that it may undergo a more complete maceration and softening by its secretion prior to entering the abomasum. The food, which has passed the three first stomachs, now enters the fourth, where it is subjected to the action of a particular solvent fluid called the gastric juice, by which it is converted into a chymous mass. This viscus, which is marked *c* in figs. 6 and 7, is commonly called the rennet, probably from the circumstance that the preserved fourth stomach of the calf is used to coagulate the milk in the making of cheese: a fact which is referrible to a chemical action of the acid of the gastric juice upon the casein

of the milk. The internal tunic of the abomasum differs altogether from that of the other stomachs: it has a velvety appearance, and is therefore designated a villous membrane. The villi or shaggy projections of which it is composed are intimately connected with the secretion of the fluid referred to. The membrane lies principally in folds, most of which run parallel with the length of the organ; at its entrance, two of them are so adapted as to prevent a regurgitation of the contents, and at the extremity, which communicates with the intestinal canal, they take an irregular course across the short diameter of the stomach. The abomasum is largest at its commencement, and gradually diminishes towards its termination; it also turns upon itself, taking an upward direction (see *e*, fig. 2), and thus are formed its greater and lesser curvature. The peculiar arrangement of the lining membrane, besides affording a large extent of surface for secretion, seems likewise to be well calculated to assist the passage of the chyme into the intestines mechanically; as the cross rugæ at the pylorus tend to support the weight of the mass passing through it, while the longitudinal plaits present no obstacle to its progress.

Digestion is mainly, if not entirely, a chemical process, in which the hydrochloric and acetic acid of the gastric juice play the chief part. To enter fully into this subject would divert us from our project, and therefore we proceed to speak of the changes effected in the intestinal tube on the chymous matter. We will first, however, make a few observations on the development of the stomachs of the calf during the period of lactation. These viscera present a striking contrast with the fully formed stomach of the adult ruminant, for we find the abomasum to be the largest, and to be the only one actively employed at that time. This arises from the fact that the milk requires no preparation to suit it for diges-

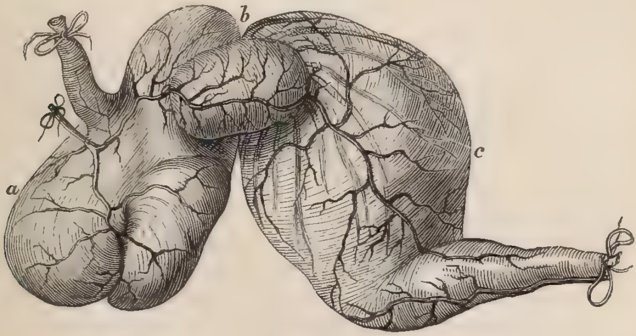


Fig. 7.

*a*, The Rumen *b*, The Omasum. *c*, The Abomasum.

tion, and, consequently, it passes directly from the œsophagus into the fourth stomach. Its conveyance into this organ is effected by the muscular pillars of the œsophageal canal, which incontrovertibly proves that their function is to draw the opening of the third stomach towards the termination of the œsophagus, and in doing this they also approximate the entrance to the abomasum to the same part; as in the young animal the opening may be said to be common to both these stomachs. The annexed sketch will show some of the peculiarities here pointed out.

The aliment, having been sufficiently acted on by the gastric juice, enters the first intestine, *the duodenum*, where it undergoes the process of chylification, by which its nutritious parts are separated, and further prepared for the support of the animal.

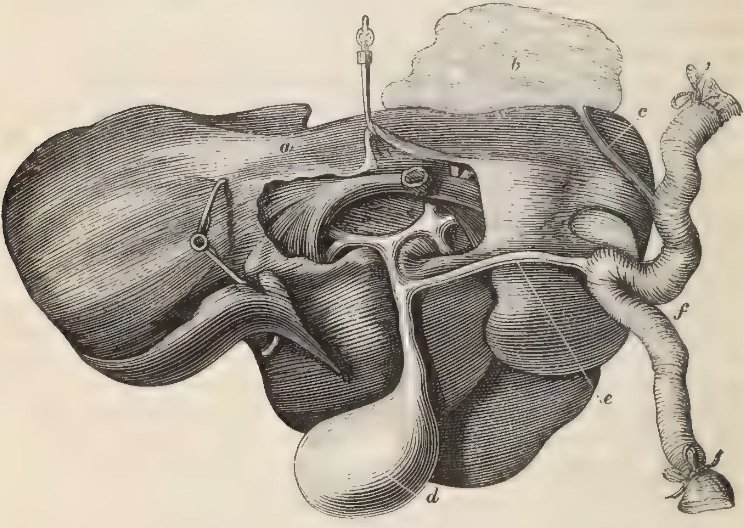


Fig. 8.

*a*. The Liver. *b*, The Pancreas. *c*, The Pancreatic Duct. *d*, The Gall-Bladder. *e*, The Biliary Duct. *f*, The Duodenum.

Chylification is effected by the commingling of two particular fluids with the chymous mass, and, like digestion, is essentially a chemical action. The fluids producing this important change are the bile and the pancreatic juice, the former of which is secreted by the liver, and the latter by an organ called the pancreas. These secretions find their way into the duodenum by the excretory ducts of the two glands, but their course and termination differ in the several animals we are describing. In the ox, as seen in the accompanying figure, the biliary duct, *e*, enters the intestine at some distance from the pancreatic duct, *c*. In the sheep the

pancreatic joins the biliary tube before the latter penetrates the duodenum, and in the horse and the pig the two enter close to each other. These facts are difficult of explanation, but of great importance to the comparative physiologist. It is also worthy of note that some animals possess a receptacle for the bile, called the gall-bladder, *d*, while it is wanting in others. As a rule it is not met with in the pachydermata, of which fact the horse is an example, and the pig an exception. The carnivora possess it, and it is generally present in the ruminantia, but is wanting in the camel and the deer tribe.

As before stated, the secretions of the liver and pancreas produce a separation of the chyle from the ingesta; this is precipitated upon the villous membrane of the intestines, from whence it is removed by a particular set of absorbent tubes, the lacteals, into the general circulation. These vessels are represented as lines crossing the mesentery (figs. 9 and 10); they receive their name from the milky appearance of the chyle. In their course many of them enter the mesenteric glands (see *g*, figs. 9 and 10), where the chyle is further elaborated. The lacteals unite with each other and ultimately form three or four ducts, which empty themselves into a cavity situated near to the spine, termed the *receptaculum chyli*. From this receptacle the fluid is conveyed by a canal, which, passing through the chest, receives the name of the thoracic duct, into the left jugular, or sometimes into the left axillary vein, where it is commingled with the blood.

We observed at the commencement of this lecture that the blood carries by its circulation the elements of reproduction and nutrition to every part of the body; it is therefore evident that it must suffer loss, and we have now seen how this is compensated by the food on which the animal subsists. To preserve health it is of the first importance that good and nutritious diet, such as will neither cloy the appetite nor impair the digestive process, should be given to all animals, for, without due attention to this, disease will be a certain result. The wants of the system are recognised by two sensations, hunger and thirst; the first gives evidence of the loss of nutrient matter, the second of fluid. Hunger may be said to have its seat in the stomach, and thirst in the throat. Where health is the object, both should be satisfied, but neither indulged. Excess of nutriment accumulates in the form of fat, but fat animals are on the brink of disease. The inhalation of pure air is of equal importance to the taking of proper food, for the blood constantly requires purification as well as supply; this is effected by respiration, which, like digestion, is also a chemical process. We must not, however, enter upon this subject, but return to our description of the intestines.

The intestinal canal, although continuous, is divided into six

sections: these are generally spoken of as distinct intestines, and named, *the duodenum, a; the jejunum, b; the ileum, c; the cæcum, d; the colon, e;* and *the rectum, f.* They admit likewise of a separation into large and small; the first three belong to the latter, and the last three to the former division. These viscera vary in length, even in animals belonging to the same class, and are relatively longer in the sheep than in the ox. They are longest in the herbivora, shortest in the carnivora, and hold a middle position in the omnivora. In the horse the disproportion between the large and small bowels is very great, but in the ox, sheep, and pig this is not the case. Like the stomachs, they have three tunics or coats: an external or serous, which secretes a fluid to prevent attrition in their movements; a middle or muscular, which maintains the peristaltic action; and an internal or villous, which promotes the absorption of the nutrient matters passing within them. As chylification is effected in the duodenum, this leads to the chyle being chiefly absorbed from the small intestines; and hence we find them thrown into countless convolutions, of which the sketches on the following page furnish an illustration.

Fig. 9 gives a view of the intestines of the ox as seen on the right side; and fig. 10 those of the sheep on the left side: the references are the same in both. *a*, The duodenum; *b*, the jejunum; *c*, the ileum; *d*, the cæcum; *e*, the colon; *f*, the rectum; *g*, the mesenteric glands, with the lacteals passing to and from them. The large intestines receive the ingesta, from which the nutriment has been extracted, and from them absorption of ordinary fluids takes place; the dryness of the fœculent matter will consequently depend on their length and the amount of fluid which is removed. Increase of length leads to retention, and this to augmented absorption, so that the difference in the alvine evacuations of the ox and sheep admits of an easy explanation, for in the sheep the colon is much more convoluted than in the ox (compare figs. 9 and 10).

To dwell longer on these anatomical facts would be to unnecessarily occupy your time, our object being to give a mere outline of the peculiarities of structure, that you may better understand both the functions and diseases of the organs we have been describing. We will therefore proceed to the pathological division of our lecture, and first speak of an accident of very frequent occurrence among cattle and sheep, namely, Choking.

Choking, or the impaction of a foreign substance in the œsophagus, is common among oxen, more especially when they are fed on bulbous roots; a practice which is usually adopted in fattening them for the market. The improvements which have been effected in the construction of machines for cutting turnips,

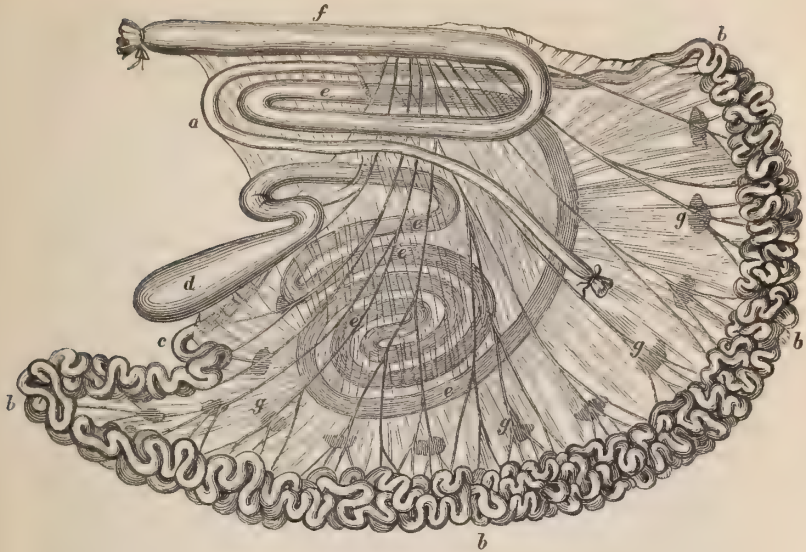


Fig. 9.

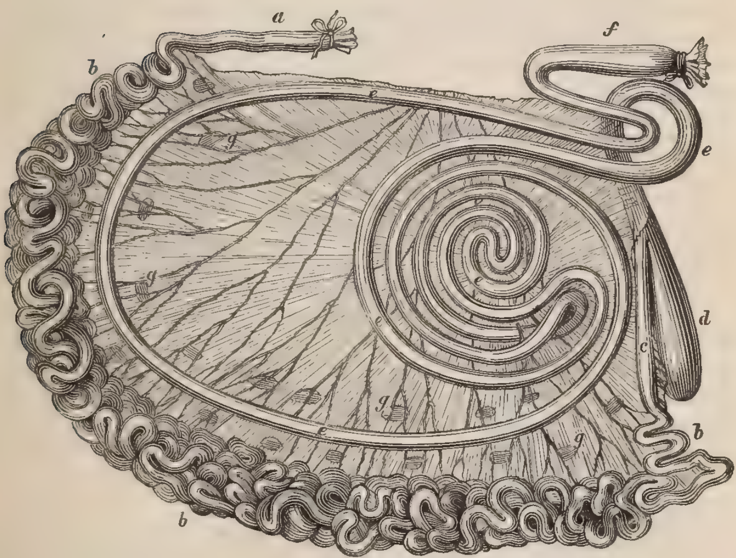


Fig. 10.

mangold-wurzel, &c., have materially diminished the number of these accidents; nevertheless from time to time they occur, and are attended with serious consequences. Although most cases of choking depend more on the preparation than on the kind of provender, still many arise from a habit that some oxen acquire of feeding greedily, and badly masticating their food. An ox that has once been choked is more liable to a second occurrence of the accident, and practical feeders of cattle are well aware that some bullocks will very frequently choke themselves when they are kept on tuberous roots. In cases of this description, although an operation is seldom necessary, still the animals require more than ordinary attention, for their own efforts to dislodge the obstruction may be fruitless, and, consequently, suffocation may take place.

There are two parts of the gullet where the root is most likely to be lodged, the one being at the origin of the tube from the pharynx, the other near its termination in the rumen. If the root is impacted high up, it is a proof that it is large, and great care is then required in our operations to remove it. Very large portions will rarely pass beyond the pharynx, and under such circumstances no attempt should be made to force the root downwards, for the œsophagus would assuredly be lacerated. In these cases the hand should be passed into the mouth, and carried backwards sufficiently far to lay hold of the root, and draw it out, using as a protection to the arm a gag similar in form to an ordinary balling iron. When this proceeding is impracticable, an instrument consisting of spring forceps concealed within a hollow bulb, from which they can be thrust at pleasure, may be employed. In these operations an assistant is especially required, who should grasp the throat a little below the impacted substance and press it towards the operator.

The distress exhibited by the animal, as well as the danger, is always in proportion to the size of the offending mass and its situation within the gullet. When high up, the symptoms usually are, frequent cough; quick and laboured breathing; painful expirations; extended head; frequent eructations; discharge of viscid saliva; efforts to regurgitate; tympany of abdomen on the left side, accompanied with great uneasiness; acceleration of the pulse; &c. The patient rarely lies down, or experiences any relief until the obstruction is displaced; but, on the contrary, the pain becomes increased, the abdomen more distended, and the respiration difficult; in which condition he staggers to and fro, falls, and dies from suffocation.

When the impacted substance is situated low down, there is less discharge of saliva, rarely any cough; the tympany is slight, and the breathing but little disturbed. The animal separates himself from the herd, is disinclined to move, stands poking the head,

and making repeated attempts to regurgitate, which are associated with eructations.

The amount of danger may mostly be calculated by the abdominal distention, for death results from the lungs being unable to expand, in consequence of the pressure of the rumen against the diaphragm. In many cases, therefore, prior to unchoking the patient, the gaseous compounds which are disengaged from the ingesta and distend the rumen must be given an exit to, by puncturing that viscus, to prevent suffocation. The instruments employed for unchoking consist of a probang and a gag; the latter of these is to be placed in the mouth, as shown in the following sketch. The probang, being also held as represented, is to be passed through the opening in the gag, and carried carefully over the dorsum of the tongue into the pharynx, and from thence pushed onwards until it reaches the root. Sufficient and well-regulated pressure is now to be made, until the obstruction yields, when it is to be driven by the instrument into the rumen. Care should always be taken *to propel the root into the first stomach,* and we should never rely on the power of the œsophagus to do this after we have succeeded in removing it from its original situation. Want of attention to this simple rule has often caused protracted suffering to the animal, and not unfrequently his death. The probangs in ordinary use are seldom of sufficient length, nor are the bulbs with which they are tipped of a proper shape: the instrument should not be less, for a moderate sized ox, than six feet and a half long, and the bulbs should be large and slightly cup-shaped. In selecting probangs, avoid those which have conical-formed bulbs, for they are likely to pass by the side of the root and force it through the coats of the œsophagus.

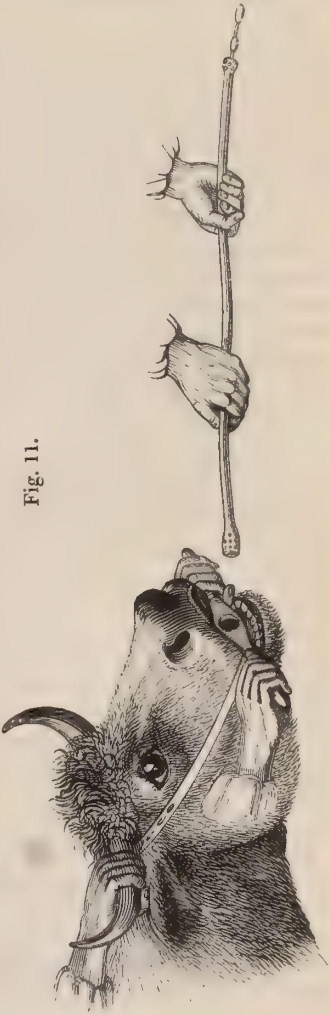

Fig. 11.

The operator should always proceed steadily, and not go hastily or roughly to work, for with the greatset care the gullet will sometimes be injured, and the animal be rendered nearly valueless. The relief which immediately follows the removal of the root affords the best evidence that no injury has been done, for, should the patient experience but little mitigation of the symptoms, or should the instrument when withdrawn be found to be tinged with blood, we have sure proofs that the œsophagus is lacerated. Under such circumstances it is better to destroy the animal, for, although slight lesions of the gullet will heal, still even these are generally followed by stricture.

Two assistants at least will be required in all cases of choking: one of these should be placed on either side of the animal, holding the handle of the gag which protrudes from the side of the mouth with one hand, and the opposite horn with the other. They must also keep the head elevated, so as to bring it as near as possible in a straight line with the neck (see fig. 11). Some practitioners drench the patient with oil prior to using the probang; we, however, object to this as being not only unnecessary, but likely to cause mischief by the fluid passing into the windpipe, and for the same reason we condemn the common practice of dosing a choked beast with salt and water, or other irritating agents. Cases offering more than an ordinary amount of resistance should be committed to the care of the veterinary surgeon, who will adopt many expedients which we cannot speak of in a lecture of this description, our chief object being to lay down simple and broad rules for your guidance.

We will now offer some remarks on Acute Tympanitis, or, as it is generally called, Hove. This disease may occur at any period of the year, if cattle are subjected to a sudden alteration of diet; it however takes place more often in the spring and autumn. Oxen after confinement to the straw-yard during the winter months will be found, if at once they are turned into luxuriant grass, to greedily devour the herbage; over distention of the rumen is thus produced, which is quickly followed by tympanitis. A similar derangement of the digestive function will likewise happen when cattle are first put to turnips in the autumn. One or other of these circumstances is the more frequent origin of the affection, and therefore greater care should be exercised in the management of the animals at these particular times.

Rapid gathering of the food is necessarily associated with both imperfect mastication and insalivation, and, besides these causes of impaired digestion, the sudden repletion of the rumen weakens or suspends its ordinary peristaltic action; hence the aliment goes into a state of fermentation. Or we may explain the phenomenon by saying that, the laws of vitality being interfered with, those of

chemistry come into operation, when gaseous compounds are eliminated from the ingesta which is contained in the first stomach, instead of its being therein prepared for digestion. The increased susceptibility of cattle to "hove," if turned out while the dew is on the herbage, has led to the affection being called "dew-blown," "fog-sickness," &c. Benefit not unfrequently results from the application of these popular names, for agriculturists learn thereby the necessity of keeping their oxen from the pastures until the sun's rays have dissipated the dewy mist of the previous night.

Investigation into the nature of this disease unfolds the plan of successfully treating it; and perhaps in no other instance have we a more convincing proof of the advantages which spring from the application of the science of chemistry to pathology. Hove is sudden in its attack, and speedy relief must be afforded, or the patient will be lost. The fermentation which the food undergoes is facilitated by the heat and moisture to which it is exposed while in the rumen, as well as by the causes previously alluded to. The gaseous compounds produced by the fermentative process vary according to its duration; at first carbonic acid gas is evolved, but in a short time this product gives place to carburetted hydrogen gas. We learn from this fact that the neutralizing agents must be selected with reference to the time which has elapsed since the attack. The preparations of ammonia, of which the aromatic spirit is the best, will effect the desired object at the commencement; but these should never be given in a protracted case, as they would then aggravate the evil. The carburetted hydrogen gas is effectually neutralized by chlorine, which agent can be easily and safely exhibited in the form of chlorinated lime.

The dose of the ammoniacal compound will range from one to three ounces, and of the chlorinated lime from two to four drachms; a small quantity of water should be added to these medicaments, prior to either of them being administered. No delay should take place in adopting the necessary treatment, or the patient may be lost, for death in this disease, as in choking, is caused by suffocation. The inertia of the coats of the rumen, which has been previously described, will sometimes yield to such stimulants as the tincture of ginger, &c., but these remedies ought not to be alone depended upon, for they possess no specific properties to stop the fermentative process. In conjunction with chemical agents they may be employed with great advantage, as they assist in dispelling the gas by rousing into action the muscular coat of the rumen.

To give immediate relief in tympanitis, the operation of paracentesis (puncturing the rumen) is had recourse to, and

often with great benefit. Occasionally, however, but very little gaseous matter escapes through the opening, a circumstance that depends upon the non-separation of the gas in a large and distinct volume from the fermenting ingesta. Notwithstanding but very little gas may be liberated, still an advantage is gained by the operation; for the sheath of the instrument employed in making the puncture forms a ready and convenient passage

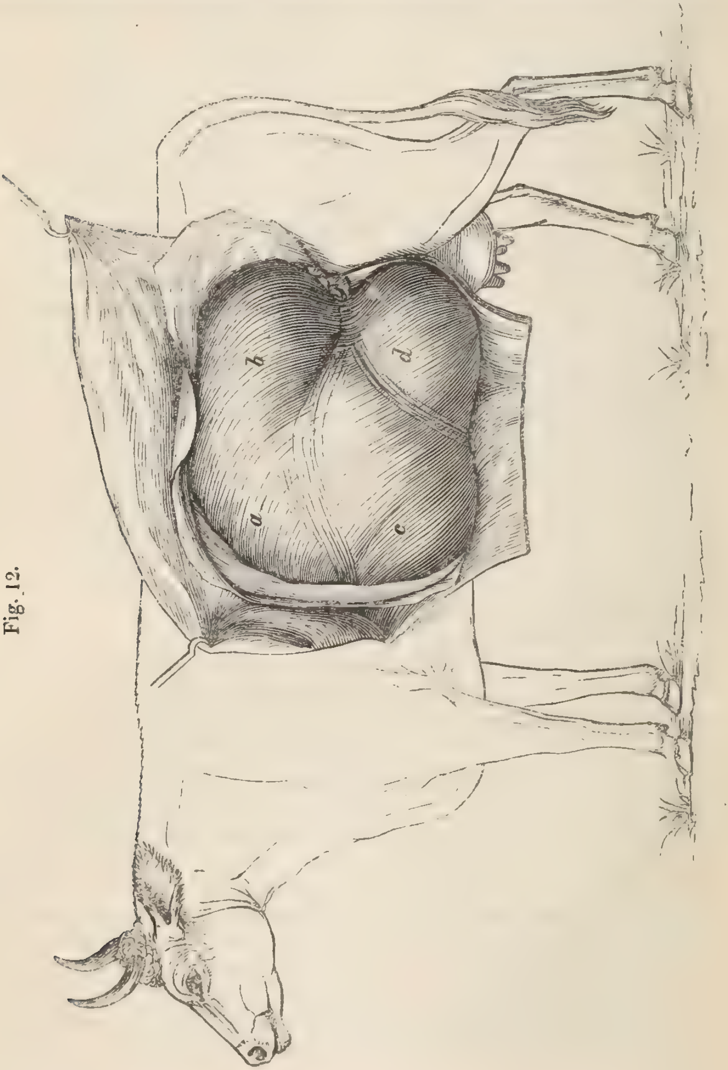


Fig. 12.

through which neutralizing fluids may be injected into the stomach; thus bringing them into immediate contact with the ingesta. It is important to bear in mind that the operation should always be performed on the left side of the animal, in consequence of the inclination of the rumen to that part of the abdominal cavity. The sketch in p. 50 exposes to view the first stomach in its natural situation. (fig. 12): *a*, the anterior pouch; *b*, the postero-superior, *the one which is opened in these cases*; *c*, the middle; and *d*, the postero-inferior. The place of puncture is represented in fig. 13: it is situated midway between

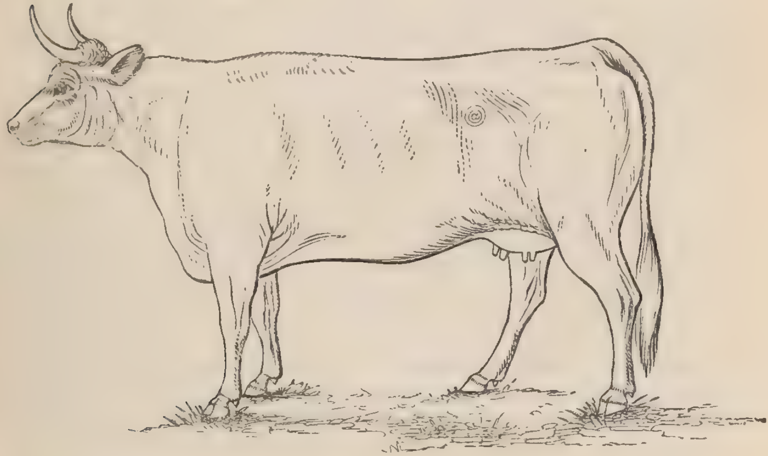

**Fig. 13.**

*a* represents the spot where the trocar should be introduced in puncturing the rumen.

the last rib and the hip, or the anterior spinous process of the ileum, and rather more than a hand's breadth below the transverse processes of the bones of the loins.

The instrument employed is called a trocar (*see* fig. 14); it consists of a stilet, having a lancet-shaped point, and a canula or sheath. The stilet should be about six inches in length, and

Fig. 14.

when placed within the canula it should protrude about three-fourths of an inch; its diameter may vary from three-eighths to half an inch. In performing the operation, it is best to first puncture the skin with a lancet; which having done, insert the point of the instrument in the wound, *and thrust the stilet covered by the sheath inwards and slightly downwards*, using sufficient force to penetrate the coats of the rumen; afterwards withdraw the

stilet, leaving the canula in the situation. The canula is to remain until the gas has escaped, when it is to be removed, and the edges of the wound in the skin brought together by a stitch of strong silk. The subsequent treatment of the patient must be regulated according to the amount of the constitutional disturbance; in the majority of cases a strict attention to the quantity of the food, and taking also especial care that the quantity is restricted, will be all that is necessary to restore the animal to health. In other instances aperient medicine, followed up by febrifuges, will be required, or a bloodletting may be necessary if the symptoms denote the existence of inflammation. But such cases ought to be confided to the care of a veterinary surgeon.

Having already exceeded the limits of an ordinary lecture, and trespassed far too long on your valuable time, I will, in conclusion, make a few observations on Spasmodic Colic, a disease that is ordinarily called Gripes; and it is the more necessary to do this, for this affection is frequently mistaken for some others of a very different character. Spasm in the horse is chiefly confined to the small intestines, and it may be said to essentially consist of an abnormal or inordinate contraction of the muscular coat of these viscera. In the ox and sheep, in addition to the liability of the intestinal canal to be affected, the muscular fibres of the stomachs, more particularly the first, are occasionally the seat of the disease. The annexed sketch will illustrate the condition of the bowels when attacked with spasm; and also show a common result of the disorder, namely, intussusception, or the passage of one portion of the bowel within another.


Fig. 15.

*a*, Contracted or diseased portions of the bowel. *b*, A portion slit open to show, *c*, the part which is intussuscepted.

We have before alluded to the peristaltic action which continually goes on in the intestines to effect the removal of the effete matter. In spasm this motion, although interrupted, is not suspended, and, the abnormal contraction of the canal diminishing its calibre, the part is thus pressed within the dilated portion, and strangulation ensues. Intussusception would be an almost invariable consequence of the disorder, were it not that the mesentery, which attaches the intestines to the spine, also limits their motion. Nevertheless, when once invagination takes place, it gradually increases; the mesentery tears, and several feet of the bowel will then become impacted—a circumstance that is always attended with an aggravation of the patient's sufferings, ending in death. Oxen and sheep are less prone to intussusception than the horse, for in them the mesentery is shorter, and so arranged that the intestines can scarcely be strangulated in this manner.

The causes of spasm are various, and among the principal may be named the drinking of a large quantity of cold water when the body is heated ; the partaking of coarse indigestible provender ; over exertion, more especially when the stomach is loaded with food ; and checked perspiration by exposure to a low temperature or storms. The attack is generally sudden, and there are seldom any premonitory symptoms. In the horse the indications of the existence of the disease are shown by crouching ; throwing the body on the ground ; rolling when down, quick rising ; curling the tail ; stamping and pawing with the fore feet ; striking at the belly with the hind ones ; turning the head to the flank ; &c. Neither the breathing nor the pulse is, however, much disturbed, except during the paroxysms ; and it is also a peculiarity of the disorder that it is marked by intermissions of the sufferings. Besides intussusception, spasm is very likely to terminate in inflammation of the bowels, when all the symptoms are increased in severity ; the pulse rises and becomes thready, the artery feeling like a vibrating cord beneath the fingers ; the breathing is increased ; perspirations bedew the body ; the intermissions cease ; and the vital powers are gradually but speedily exhausted. Want of attention to a change in the symptoms has led to many a valuable animal being sacrificed, because the medicinal agents which are best calculated to remove spasm will be productive of great mischief if given when inflammation is present, by adding to the morbid action which is going on. It is therefore apparent that cases of gripes, if not quickly yielding to the ordinary remedies, should immediately be placed under the care of a skilful practitioner, who alone is capable of deciding on the plan of treatment which is necessary to be adopted. I would wish to impress this forcibly on your minds, for, were I to attempt to

give you instructions with reference to the treatment of inflammation of the bowels, I feel that I should be doing that which would be positively injurious to your interests. No one excepting those who have made the subject of the diseases of the lower animals their study, should ever undertake the management of such cases. With regard to spasmodic colic, it is to be remembered that it is not an inflammatory disease; even bleeding, therefore, although it is a powerful relaxer of spasm, is not absolutely required under such circumstances; but when inflammation exists, this must be our chief remedy. Stimulants are admissible in the one disease, but highly prejudicial in the other. One of the best formulas to be administered in spasmodic colic is composed of Ol. Tereb. ℥ij., Spts. Æther Nitric. ℥j., et Tinct. Opii ℥j. This should be given early, and repeated in about an hour if relief is not obtained; after which a continuance of the pain would point out the necessity of calling in the aid of the veterinary surgeon. As an adjuvant frictions to the abdomen should be employed; and the animal's comforts attended to as much as possible, by placing him in a roomy and well-littered stable or shed, where he can sustain no injury in his struggles during the exacerbations of the malady.

And now, having endeavoured to communicate to this Meeting some information on the structure, functions, and diseases of very important organs of the body, I would, while I offer to you my best thanks for your kind attention to my imperfect observations, venture to hope that a spirit of inquiry will be awakened on this subject; for by it each will gain something, and the grand object which this noble Society labours to accomplish, namely, to blend "practice with science," will be likewise promoted.

## III.—*On a Method of breaking up inferior Pasture Land.* By Francis Woodward.

Having been requested by Mr. Pusey to publish the method I have adopted for converting inferior pasture-land into tillage, I feel great pleasure in so doing.

In the commencement of the winter of 1844 there was a very considerable number of labourers out of employ in my neighbourhood, and, having 20 acres of inferior pasture in high ridges (growing rushes in the furrows and moss on the tops of the lands), I thought these might be very profitably converted into tillage, and I adopted the following system:—

I commenced by skimming or paring (on the top of the ridge) the turf about two inches deep with the old-fashioned skim-

plough, which left the furrows open, or at least free from turf, ready for draining, which operation I performed *three feet* deep and 27 feet between the drains, at a cost of 70*s.* per acre, including tiles. I then dug a trench across the ridge four feet wide, throwing the first graft of good soil on one side; I afterwards threw the subsoil from the ridge part of the land into the furrows, making the lands almost level. I then laid the turf (with a fork) bottom upwards upon the subsoil, which had been stirred, and commenced digging a fresh trench, the upper graft of which I placed upon the turf, so that the turf was deposited about nine or ten inches under the surface and between the two grafts of soil.

I allowed the field to remain two years, only working the surface, and grew two crops of wheat from the maiden soil. In the third year I ploughed it very deep, and the turf came up a beautiful rich black vegetable mould, in a fine state to produce two more crops of wheat, making four crops of wheat in succession from a piece of land not worth more than 25*s.* per acre in its original state. The whole cost was after the rate of *seven pounds ten shillings* per acre; viz. 70*s.* per acre for draining and 80*s.* per acre for double digging. I was thus enabled, independent of other advantages, to give employment to 40 labourers for nearly two months in the dead of winter.

In the first year I sowed Red Cluster Wheat, broad-cast, the last week in February, at the rate of three bushels per acre. Of course, after double-digging the land was very hollow (not having at that time that most valuable implement, Croskill's roller). I had it trod with 24 horses for several days, until it became firm as a road. The produce at harvest was 42 bushels per acre, which I sold at 7*s.* per bushel, making 14 guineas per acre of the first crop. The second year it produced 50 bushels per acre from 2½ bushels of seed drilled eight inches apart; the third year 48 bushels from 2½ of seed; and it is now planted for the fourth year with wheat, the only manure applied being 2½ cwt. of Peruvian guano per acre. The crop promises to be very good.

I attribute my success to having buried the turf a sufficient depth, so as not to interfere with the grain until properly decomposed, and also to my having had the surface made firm by great pressure, which I think prevented wire-worm and destroyed other insects.

*Little Comberton, Pershore, May* 30, 1848.

## IV.—*On the Phosphoric Strata of the Chalk Formation.* By J. Manwaring Paine and J. Thomas Way.

[Note by Mr. Way.—The analyses which have been incorporated in the following paper were made for the English Agricultural Chemistry Association, at the instance of Mr. Paine, who is one of its members. Although it has been my good fortune to assist Mr. Paine in his investigations, and to accompany him in many of his geological explorations, any amount of good which may be considered to arise from the inquiry must be placed to the credit of Mr. Paine alone, to whose indefatigable efforts in the acquisition of such information I may surely be allowed to afford my willing testimony. The reader of the following pages will find that any notion, on the part of Mr. Paine or myself, of taking credit for the *discovery* of these phosphoric deposits is absolutely disclaimed. The various branches of the subject have indeed long since been in the able hands of Dr. Fitton, Dr. Mantell, Professor Henslow, &c. With the exception, however, of the last-named observer, it would not appear that these gentlemen had studied the subject in any but a purely *geological* sense; and valuable as are the results of their labours, they cannot be said to be adequate to the application of these substances in practical agriculture. The well-known zeal of Professor Henslow in the service of agricultural science has led him to approach the consideration of these geological truths in an agricultural sense; and his discovery and recommendation of the phosphoric fossils of Suffolk and Essex have led to the extensive employment of these remains as a substitute for bones. He has since extended his observations, with the same practical tendency, to similar deposits in the upper green-sand formation. The details now given will, however, it is hoped, not be without interest, as an extension of a subject which as yet is comparatively new to agricultural readers. The analyses introduced scarcely comprehend a tithe of those which have been made in the progress of the investigation; and although many chemical facts of much interest have been observed, the pages of this Journal were not considered appropriate to their introduction, and only such have been brought forward as were thought necessary to the *agricultural* application of the subjects. For many of the analyses I am indebted to Mr. Frederick Eggar of Bentley, who has spent many months in my laboratory in this kind of mineral investigation; the remainder are by myself.—J. T. W.]

The advantages to be derived from the employment of *bones* in agriculture are at this day well known, and it were but a waste of the valuable space of the Journal and of the time of the reader to bring forward arguments and examples in favour of a manure whose merits are rarely brought in question.

But in introducing to the notice of the agricultural reader an important source of the mineral called *phosphate of lime*, it may not be altogether out of place shortly to advert to the arguments which may be adduced for the belief that bones owe much of their fertilizing powers to this ingredient in their composition.

It will be remembered that nearly two-thirds of the weight of recent bones is earthy matter, principally phosphate and carbonate of lime; the other one-third consists of a peculiar animal substance called *gelatine*, some oil or fat, and a variable quantity of moisture. For all practical purposes the phosphate of lime may be taken to average 50 per cent., or one-half, of the fresh bone.

Experience and science are equally decisive in attributing to the animal matter of bones a very important share in manuring efficacy; and whatever fluctuations may have occurred in the progress of opinion on this head, the abiding conviction in the minds of agricultural authorities at the present time is, that the animal matter of bones, like all other substances rich in nitrogen, is of very high value as a fertilizing agent.

But whilst a full share of importance is attached to the animal portion of bones, the effects which follow their application are far greater than could in the most favourable opinion be ascribed to the sole agency of this ingredient; and direct experiments are not wanting to prove that, when purposely separated from the earthy portion, the gelatine is incapable of influencing vegetation in a degree at all comparable with that which is exhibited by the compound manure.* On the other hand, the earthy portion has been employed in every variety of form with the most marked results, and trustworthy experiments (more especially those of Mr. Hannam and Mr. Lawes) have placed beyond all doubt the beneficial effect of burnt bones on the turnip crop.

Mr. Lawes, indeed, entertains the conviction that phosphate of lime exercises some special agency, apart from the mere supply of a necessary ingredient of the structure of the plant; but be this as it may, there is abundant evidence of the high powers, as a manure, of the phosphate of lime in bones. Of another kind, but not less striking, is the evidence derived from the analyses of plants, and of the soil in which they grow. In all the plants or parts of plants which are of any great nutritive value, phosphate of lime or some other compound of phosphoric acid is always to be found in large quantity, whilst the proportion in which it occurs is for the same plant so uniform as to preclude all question that it is essential to their very existence. When therefore, on the other hand, we are sometimes unable, with the aid of the most refined processes of analytical chemistry, to detect more than the merest traces of phosphoric acid in a soil, shall we not be justified in concluding that, properly applied, the compounds of this acid must be beneficial to the growth of crops on such a soil?

The attention of men of science and of agriculturists has from

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* See Mr. Hannam's Experiments, in the 6th volume of this Journal, part i.

time to time been directed to the inquiry, whether there existed any available source of phosphate of lime capable of furnishing this mineral for the use of the farmer at a cheaper rate than he obtains it in bones, or adequate to replace them if their supplies should fail.

It is needless to advert, except in the most cursory way, to guano, which is chiefly valuable for the ammonia and phosphate of lime contained in it. The Peruvian guanos certainly owe their greatest efficacy to the large proportion of ammoniacal salts which they contain; but some other kinds (as the Saldanha Bay guano) must be considered in the main as vehicles for phosphoric acid.

In the year 1843 Dr. Daubeny undertook a geological expedition to the province of Estremadura in Spain, for the purpose of inspecting a bed of phosphate of lime which was said to occur in that district, but concerning which only the most vague and unsatisfactory information was at that time possessed.

Dr. Daubeny's account of this phosphoric bed is in the highest degree interesting; but although very large quantities of the mineral were to be obtained, he came to the conclusion that at present, at all events, it was not likely to become available for the purposes of English agriculture. For the history of this mineral the reader is referred to the Journal of the Agricultural Society, vol. v. part ii.; but it may be well, for comparison sake, to mention here that the quantity of phosphoric acid found by Dr. Daubeny in the purest specimens was about 37 per cent., a quantity which would be equal to about 76 per cent. of the bone-earth phosphate.*

More recently the very important discovery was made by Professor Henslow that certain rounded waterworn nodules existing in the crag and London-clay formations contained a large per-centage of phosphate of lime. From the form and external markings of these singular concretions, taken with the fact that the teeth of sharks and other organic remains were frequently found in the interior of the lumps, Professor Henslow was at that time led to conclude that they were the fossil dung of a former generation of animals, and proposed for them the name of *coprolites*, by which they have since then been known.

Further observations have induced the discoverer of these fossils to modify very considerably the views which he at that time entertained of their origin, but the name is convenient, and

* Note by Mr. Way.—Dr. Daubeny considers the phosphate of lime in this mineral to be the *tribasic* phosphate ($3CaO\ PO_5$), which contains 45·5 per cent. of phosphoric acids. He found 81 per cent. of this phosphate in the substance; and from these data the numbers above are deducible.

will probably be retained. The coprolites exist in some parts of Suffolk and Essex in very large quantities; but as it is not the intention of this paper to enter upon a description of the crag coprolites, which it is to be hoped Professor Henslow may himself at some future time lay before the agricultural public, it is sufficient to state that the coprolites can be obtained in almost unlimited quantity, and that the beds can be easily and economically worked.

The proportion of phosphate of lime in these coprolites is from 50 to 60 per cent.* So far, therefore, we have in England an abundant source of phosphate of lime. It is, however, to be observed, that the coprolites are intensely hard, that very powerful machinery is required to grind them, and that, even when in powder, the phosphate of lime is not of itself sufficiently soluble for direct application to the soil. The coprolites are readily dissolved by sulphuric acid, and then afford a most valuable manure, of which many hundreds of tons have already been manufactured and used.

It may naturally occur to some person to ask, To what purpose—if there already exists an abundant and cheap supply of phosphate of lime in the coprolites of the crag—to what purpose should the agriculturist be troubled with looking for another? or in what respect are the beds of the chalk formation about to be described of interest in a practical point of view? The answer to these questions may be readily given—the mechanical and chemical processes necessary to prepare the Suffolk coprolites for agricultural use must doubtless, to a certain extent, prevent their being brought into the market at so low a price as they might be, were such preparation unnecessary.

On the other hand, there is reason to believe that the phosphoric substances of the upper and lower green-sand may, without chemical preparation of any kind, be applied to the turnip and other crops with great benefit, and (as will be shown in this paper) that they may be reduced to the requisite degree of fineness by simple and inexpensive machinery.

Again, it is confidently believed, that by proper investigation, founded upon the details here brought forward, every occupier of land lying on given zones of the chalk formation may find, either in phosphoric fossils or phosphoric marls, the means of very materially increasing the productiveness not only of his own

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* Note by Mr. Way.—Two analyses of the coprolites made in my laboratory gave phosphoric acid equal to 52 and 54 per cent. of bone-earth phosphate. Dr. Gilbert informs me that in several analyses which he has made of samples taken from many tons of the ground coprolites, he has found the percentage of bone-earth phosphate to be very uniformly between 55 and 57 per cent.

fields, but of those of his neighbours, for some distance on either hand, and that thus a band of country of many miles in breadth, and extending with the chalk through this island in more than one direction, may experience the advantage of a cheap supply of one of the most valuable of mineral manures. Whether or no these advantages may be confined to the localities of the chalk formation, it is difficult at present to say; such information as it is in the power of the authors to afford him the reader will find in the following account of the phosphoric strata, which it is the intention of the paper to introduce to his notice.

The series of strata termed by geologists the Cretaceous system does not consist exclusively of chalk, as the name implies, but comprises a large proportion of both sand and clay in the definition. It will be necessary, however, for the elucidation of the special object of the present paper, to refer occasionally to members of the whole group, although the principal deposits largely impregnated with phosphoric acid are confined to specific zones in certain subdivisions of the strata. Many of these divisions abound in fossil shells, corals, &c., which are exclusively of marine origin; these, with the occasional presence of drifted wood, generally perforated by marine animals, prove the formation to have been deposited at the bottom of an ancient sea.

The cretaceous group has been divided into the chalk and green-sand formations; and these again subdivided—the former into

1. Soft white chalk with flints;
2. Hard white chalk with few or no flints;
3. Chalk marl;

and the green-sand formation into

1. Upper green-sand and firestone rock;
2. Gault, or blue marl;
3. Lower green-sand—made up of iron-sand and occasional limestone.

An inspection of a geological map of England will show the ranges and extent of the chalk group.

One range commences at Flamborough Head in Yorkshire, and runs in a S.W. direction to Bury St. Edmund's, and continues without much interruption through Wiltshire and Dorsetshire to Sidmouth in Devonshire. A second, constituting the North and South Downs, commencing at Dover in Kent, runs through Surrey to Alton in Hampshire (where it unites with the former range, extending across the whole county into Wiltshire), and then turns back through Sussex to Beachy Head. The third comprises the southern half of the Isle of Wight.

The first two divisions of the chalk formation, viz. the soft white chalk with flints and the hard white chalk without them, are so extensively developed in many parts of the kingdom, and their general characteristics are so well known, that it will be unnecessary to occupy the pages of the Journal by any minute description. Wherever these sections of the chalk are not thickly

covered with the detritus of other formations, the soil in its agricultural character is usually of a thinnish poor nature, though under good cultivation it can be made to produce excellent crops, especially of turnips, barley, and wheat. Upon these soils the application of bone manure has proved essentially beneficial—in fact it has been the means of reclaiming whole districts from sterility. Subsequent analyses of these chalks show them to be deficient in phosphoric acid: hence the cause of the benefit produced by the application of phosphate of lime in the form of bone manure. The following is a partial analysis of the upper soft white chalk:—

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| Carbonate of lime . . . . | 96·06 |
| Phosphate of lime . . . . | ·26 |

in 100 parts—with a little insoluble silicious matter, &c., not estimated.

An examination of a portion of the hard white chalk without flints, though there were many fragments of fossil shells mixed up with the mass, gave scarcely a trace of phosphoric acid.

The third division, or the chalk marl, contains more argillaceous matter in its composition. It is generally of a soft texture and of a dirty-grey colour, and it readily decomposes into a fine powder when exposed to the vicissitudes of the weather. In many districts this stratum of marl has been extensively quarried for the purposes of manure; and in earlier times it appears to have been applied to a much greater extent than in the present day. Wherever it outcrops, the soil is distinguished for its fertility. The prolific crops of wheat, beans, and clover which are grown with the aid of a comparatively small quantity of manure evince its productive capabilities. The application of bones has usually failed in producing any apparent benefit. Here again the analysis of this soil demonstrates one cause of the failure, by indicating a sufficient amount of phosphoric acid previously existing as one of its component parts. It has very generally been experienced that manures richly charged with nitrogenous matter have proved signally useful on this class of soils. An analysis of a specimen of this marl, taken from a pit whence thousands of loads had formerly been dug, gave the following results:—

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| Insoluble silicious matter . . . . . | 19·64 |
| Soluble silica . . . . . . | 6·45 |
| Phosphoric acid (equal to 3·75 bone-earth) . | 1·82 |
| Carbonic acid . . . . . . | 28·98 |
| Lime . . . . . . . . . | 37·71 |
| Magnesia . . . . . . . | ·68 |
| Oxide of iron and alumina . . . . | 3·04 |
| | 98·32 |

Immediately below the soft marl-bed the first division of the green-sand formation commences, viz. the upper green-sand and firestone rock. In its lithological and chemical character it is in reality a continuation of the superincumbent chalk strata, and has no connexion but in name (some parts of Devonshire perhaps excepted) with the lower green-sand.

It commonly comprises three distinctive subdivisions. The first is a thin green band of marl, more or less silicious, abounding in organized fossil remains; it lies below and is in contact with the soft dirty-white marl above mentioned; in thickness it varies from a few inches to ten and fifteen feet. To this division the attention of agriculturists is particularly invited, it being most remarkably rich in phosphate of lime. It rests upon a rubbly mass of broken-up rock, from 10 to 20 feet thick, which is also impregnated with a notable quantity of phosphatic matter. In this lower mass are nodules of a purely white substance (an analysis of which is afterwards inserted) thickly interspersed, which, with the peculiar green colour of the bed above them, may be serviceable as a means of identifying the stratum in different situations.

The second subdivision is the firestone rock, or building stone. Its thickness is extremely uncertain; in some places consisting merely of one bed of stone, whilst in others it forms a series of layers, the aggregate thickness of which reaches to nearly 100 feet, as for example at the Undercliff of the Isle of Wight. This rock becomes softer in its lowest position, and gradually merges into a soft clayey marl, which constitutes the third subdivision. This again in its inferior parts becomes more and more argillaceous, until it is finally lost in the gault or blue marl stratum.

The soil derived from the débris of the whole of the upper green-sand is notorious for the luxuriance of its crops, especially those of wheat and hops. In the counties of Kent, Surrey, and Hampshire it is in this particular geological formation that some of the richest plantations of hops flourish.

The gault, which divides the upper from the lower green-sand, is most unmistakably recognised by its blue colour, almost merging into black in its lowest parts, and also by its wet clayey texture. In its natural condition it is best adapted for pastures, and is celebrated for the growth of splendid oak timber; but when this soil is deeply and thoroughly drained, it is capable of producing the heaviest crops of wheat, beans, clover, hops, &c. The fossils in this stratum, though, as at present known, too few to be collected for agricultural purposes, are invariably, amongst the specimens yet discovered, the richest in phosphate of lime.

The lower green-sand in some districts is very largely developed, containing within its limits soils possessing every grade of natural fertility—from the poor arenaceous heathlands of Surrey to the rich ragstone rock in the neighbourhood of Maidstone. It is remarkable in one of its characteristics, as well as interesting

in its relation to the object of the present paper, as at its junction with the gault it constantly discloses a bed of fossils in large quantities, in which phosphate of lime forms the chief ingredient. Other portions too, in some localities, contain bands of fossils which are rich in this substance. To the upper bed, however, most importance is attached, on account of the singular persistence of similar phosphatic deposits below the whole range of the gault.

The preceding brief general description of the strata involved in this narrative will probably not be found minutely applicable to every neighbourhood, but it is believed to be correct in its main features, and will serve to indicate the localities in which phosphoric remains are likely to be discovered in the vicinity of the chalk. With these preliminary observations it may be well to proceed to detail such particulars relative to the discovery, exact position, and practical application of the phosphatic strata of the whole cretaceous system, as have been noticed by the authors, or recorded by other observers. In the necessarily hurried examination of the works of geological writers, it is probable that some things may have been overlooked which are pertinent to the object in view; and some works in which allusions may have been made to this subject possibly have not been referred to at all. In either of these cases an apology is offered, it being an intention most remote from the wishes of the writers to withhold from previous observers their due meed of merit, or to appropriate to themselves without acknowledgment the labours of others.

Reverting to the first subdivision of the upper green-sand, or zone of fossiliferous green-marl, the position and thickness of which have been noticed above, it may be advisable here further to observe that the greenest marl is not always the richest, but, on the contrary, that which is intermixed with calcareous matter of a white and brown colour affords the largest percentage of phosphoric acid. The fossils which are enveloped in the marl are by no means evenly dispersed through the bulk, but often lie in most irregular heaps. In this respect, indeed, as well as in the thickness of the deposit, there seems to be no approach to uniformity. Frequently, however, as will be hereafter shown, the fossils are found in great abundance, and their principal constituent is phosphate of lime. These organic remains comprise a great variety of zoophytes, many shells, echini, ammonites, fishes' teeth, and wood. A large proportional ingredient of the marl itself, when separated from the fossils, is also phosphate of lime, containing frequently from 10 to 15 per cent., and in some instances even more.

On referring to the geological map, we may trace the line of upper

green-sand along the escarpment of the chalk ranges, with which it is highly probable that the zone of phosphoric marl is co-existent. In the first-mentioned range, the following places may be particularised, in the vicinity of which it is likely to be found: commencing with Flamborough Head, Bridlington, Beverley, and Kingston-upon-Hull, in Yorkshire; Barton, Brigg, Spilsby, Wainfleet, in Lincolnshire; Hunstanton, Snettisham, Middleton, Narborough, Downham, in Norfolk; Brandon, Mildenhall, Upware, Swaffham Prior, in Suffolk; the neighbourhood of Cambridge, and thence to Baldock, Hitchin, Tring, in Hertfordshire; Woburn, Dunstable, in Bedfordshire; Wendover, Tetsworth, in Buckinghamshire; Abingdon, Wantage, Farringdon, in Berkshire; Swindon, Calne, Devizes, the vale of Pewsey, Westbury, Warminster, the vale of Wardour, in Wiltshire; Shaftesbury, Sutton-Waldron, Mintern, the neighbourhood of Dorchester, and Bridport, in Dorsetshire.

In the second range, beginnning at Folkstone, skirting the escarpment of the North Downs to Lenham, Hollingbourne, the north of Maidstone, Wrotham, and the vale of Holmsdale, in Kent; Godstone, Merstham, Buckland, Dorking, Shalford, Guildford, Puttenham, Seal, Farnham, in Surrey; Bentley, Froyle, Worldham, Selborne, Hawkley, Steep, Petersfield, in Hampshire; Harting, Elstead, Nursted, Barlavington, Sutton, Bignor, Amberley, Bury, Sullington, Steyning, Lewes, East Bourne, and South Bourne, in Sussex.

In the third, or Isle of Wight, from Culver Cliff to the south of and parallel with Bembridge, Ashy, Areton, Chillerton, Mottestone, and Shalcombe Downs, to Compton Bay; and on the S.E. coast, at the top of the Undercliff, following the inland talus of Shanklin, Boniface, and St. Catherine's Downs.

It is needless to point out the localities of the gault and lower green-sand formations, as they occupy a zone, varying greatly in breadth, parallel to the strata of the upper green-sand at the foot of the chalk-hills.

For the purpose of reference Dr. Fitton's admirable paper 'On the Strata below the Chalk,' published in the 2nd part of vol. iv. of the Second Series of the Transactions of the Geological Society, and also his subsequent paper on the Lower Green-Sand, published in vol. iii. of the Quarterly Journal of this Society, may be consulted with great advantage. The remarkable nodules containing the phosphate of lime seem to have specially attracted his attention many years ago.

Before entering upon the observations and examinations which have recently been purposely made in reference to the present subject, it may be desirable to recite what has incidentally been observed in reference to or bearing upon it in former publications, commencing with the strata of the upper green-sand.

In the 'Outlines of the Geology of England and Wales,' by Conybeare and Phillips, published in 1822, they state, p. 163, that "The indurated chalk marl is extensively quarried at Totternhoe, in Bedfordshire, and Reach, in Cambridgeshire. It is there known by the name of *clunch*. . . . . Reniform masses of radiated pyrites are common, and one singular bed is full of similar masses of yellow indurated marl,

externally of a green colour, and of all sizes from a hazel-nut to an ordinary potato. . . . . Some beds of green-sand occur near the junction, and others at the bottom of the gault, and near its junction with the iron-sand. Its organic remains seem to identify the gault with the clay at Folkstone." There can be but little doubt from this description that the fossil-beds both of the upper and lower green-sand occur in these neighbourhoods.

Dr. Fitton in his memoir on the strata below the chalk gives several sections of the subsoils, the members of some of which, from the description given of the colour and organic remains, appear to be identical with the phosphoric green marl. The following pages seem to indicate these beds: viz., at 234, giving a section at Whitecliff, near Bere, in Devonshire; 247, a section of Ridge, in Wiltshire; 257, where special reference is made to the similarity of the marl rock to that at Farnham, in Surrey; 305 and 306, where mention is made of the persistent thin band of green marl; 311, a section at Mildenhall, in Suffolk; 314, a section at Hunstanton, in Norfolk.

Dr. Mantell also, in the 'Geology of the South-East of England,' at pages 160 to 164, particularizes this band of green marl, with its characteristic fossils, as being traceable along the talus of the northern side of the South Downs.

Professor Henslow, at the meeting of the British Association held at Cambridge in 1845, stated that "a stratum of green-sand, although never more than a foot thick, occurred near the surface over many square miles in the vicinity of Cambridge; and the pebbles it contained yielded 61 per cent. of earthy phosphates and 24 carbonate of lime, the rest being insoluble." These pebbles were at that time considered to be coprolitic by Professor Henslow; but subsequently he has seen reason to modify his opinion, and does not consider these remains or those of the Suffolk fossils to be of coprolitic origin.

In a letter published in the Bury Post newspaper soon after the meeting of the British Association at Cambridge, Professor Henslow enters more fully into particulars relative to the fossils of this deposit, as well as to those of the crag in Essex and Suffolk: the extensive supply of the latter phosphatic concretions has already been adverted to in the former part of this paper. With respect to the nodules found in the green marl bed, he says that they are often filled with fossil remains, sometimes the mere casts of shells. The fossils and nodules are so manifestly of the same composition, that whoever saw them together would not doubt it; and with regard to the quantities likely to be obtained for agricultural purposes, he states that "his own opinion is decidedly in favour of their being sufficiently abundant to make it worth while to collect them."

A communication on the same subject was made by Professor Henslow to the Geological Section of the British Association at Oxford last year, but as the official reports of the meeting are not yet published, further notice of it in this place is unnecessary.

To Professor Henslow, therefore, is most willingly conceded the merit of having first brought before the public the fact of the existence of a stratum containing organic remains in the upper green-sand remarkably rich in phosphate of lime, which he considered might be found

in sufficient abundance to be profitably used as substitutes for bones. It was in effect the resuscitation of the discovery originally made through the analysis of M. Berthier, nearly thirty years since.

The circumstance which primarily induced our investigation into the nature of the peculiar green band of the upper greensand was the extraordinary fertility noticed in the crops where the outcrops of this singular marl occurred. Attention was first attracted to the properties of this soil at Farnham, in Surrey, where pits have been sunk, and collections of specimens have been made, with a view to the full elucidation of the subject. As it was from specimens of soil obtained from this place and its immediate vicinity that various analytical examinations were made for the purpose of ascertaining their chemical ingredients, it may be well, in the first place, to detail such facts connected with the external properties, or agricultural relations, of this marl as have been noticed about Farnham, and the results obtained by chemical analysis; and afterwards point out such particulars of this bed in other places as have come under our personal inspection.

In the parish of Farnham the bed traverses its whole extent from east to west, coinciding with the line of the very best hop-grounds—those which are perennially continued under hop culture. This is a remarkable circumstance, tending to confirm the opinion of the profuse abundance of phosphoric acid in the soil, as well as the facility with which the hop-plant appears to be able to assimilate the acid as it naturally exists. For the analysis of the hop proves it to be a great consumer of phosphoric acid, annually carrying off from the soil many pounds per acre, in addition to the quantity which is abstracted by the haulm and leaves, as is shown by the elements of the plant. It is not intended by this remark to convey the impression that the luxuriance of the crops on these particular soils is exclusively dependent on the amount of phosphoric acid which they contain, but as taken in conjunction with other fertilising substances, which the analysis shows to be co-existent in these soils. It has been also generally observed that in wet summers the growth of the bine of the hops upon these outcrops is too luxuriant, and consequently injurious to the crop, which invariably ripens later on these spots. In dry summers, on the contrary, the crops are unusually and conspicuously large: 28 bushels of hops were once picked on four consecutive hills on the site of one of the richest of the fossiliferous green beds, being at the rate of upwards of 4 tons per acre, or ten times the average growth of the best soils. Near this place a few years ago the top or vegetable soil was removed from a few perches of ground; and when afterwards the land was replanted with hops, they grew as well as before, without any surface-soil: this spot, too, was the site of a fossil deposit. Another instance may be adduced in proof of the unusual fertilising property of the green bed, in a field also planted with hops, where the superficial soil consisted of diluvial drift gravel about two feet thick. This field, contrary to expectation, on account of the quantity of surface-gravel, has proved to be well adapted for the

growth of hops, having produced more than average crops. An examination into the subsoil last winter disclosed a rich vein of the fossil marl 4 or 5 feet below the surface: thus the mystery was explained. In several instances the subjacent beds of marl, which were deeply covered up by drifted soil, have lately been discovered by the peculiarity noticed for many years in the growing of the hops.

The influence of this marl upon corn has been equally conspicuous; the wheat-crops especially having always exhibited a far more vigorous growth than usual upon the outcrops. There is a very striking illustration of the effect produced by a narrow band of the green marl which runs through a field of wheat now growing at the N.E. extremity of the parish. The strata here are nearly vertical, and the band is very thin, so that its direction across the field may be traced by a rank green luxuriant belt of wheat about 6 feet in width.

Near this field, in a section of a quarry of the firestone rock, may be seen a seam of the green marl only a few inches thick, lying in its usual position betwixt the hard rock below and the soft marl above; adjoining the pit is a hedgerow of ash underwood, the roots of which, having penetrated vertically in single rootlets through the chalk marl, no sooner reached the green seam than they struck off laterally, forming a mat of thick fibre—evidently showing that they, as well as wheat and hops, luxuriated in this peculiar marl. An arable field in which the green marl is widely developed near the surface is remarkable for its natural fertility, and has only received manure thrice in nearly thirty years—viz. bones, rags, and guano. Not the slightest good resulted from the bone manure, although 40 bushels per acre were put on.

The above examples are selected as affording natural indications of fertility inherent in and specially belonging to these soils.

On the east of the town of Farnham the strata are much dislocated, and the phosphoric green band, wherever it is discernible, is only a few inches thick. On the N.W. of the town, below the Castle, it commences at the upper part of the Heart Hop-gardens, running in a W.S.W. direction through Beaver's Hill and the central part of Dippen Hall farm; it is, however, frequently interrupted in its continuity by valleys which have been denuded since its deposition. Its ordinary thickness is from 2 to 4 and 5 feet, though occasionally it attains to from 10 to 15 feet.

Some parts of this bed are remarkably prolific in organic remains; but in this respect, as has been already observed, there is no regularity of distribution. In the process of digging the marl at Dippen Hall a large collection of fossils has been obtained, but there is nothing worthy of special notice in them, as they comprise almost exclusively the genera and species well known as characteristic of the chalk formation.

The sponges however, comprising varieties of every order of organization, are the most prominent and characteristic genus—beautiful specimens of the syphonia pyriformis, and other alcyonites, are profusely abundant. For splendid illustrations of these and other beautiful zoophytes, plate xv. *a,* of vol. iv. of the

'Geological Transactions,' and the plates of vol. ii. of Parkinson's 'Organic Remains,' may be consulted with pleasure and advantage.

The analysis of one of these sponges (a branching alcyonite) gave—

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| Insoluble silicious matter and soluble silica | 7·68 |
| Phosphoric acid (equal to 61·30 of bone-earth phosphate) | 29·87 |
| Carbonic acid | 8·77 |
| Lime | 42·29 |
| Oxide of iron and alumina | 6·87 |
| Water, organic matter, fluorine,* and loss | 4·52 |
| | 100·00 |

Besides the sponges of definite form, there are oftentimes associated with them, in the midst of the other fossils, immense quantities of large amorphous spongoid bodies, somewhat resembling masses of recent sponge, which, though shapeless, possess a general uniformity of structure, so as to be immediately recognised by a practised eye. Externally some of them are much eroded. They are extremely heavy for their size, and are of every dimension, varying in weight from a few ounces to 8 and 10 lbs. each.

There is a peculiarity in this class of fossils; for whilst the general mass of organic remains in the green-marl beds individually agree in their chemical composition, these spongoid bodies differ from them and from each other, at any rate so far as relates to the proportion of phosphate of lime, since it ranges in them from 5 to 50 per cent. The richest ones usually lie in the centre of the bed, and the poorer below. They vary, too, in their own component parts, being richer towards the surface. This fact was suspected; and to prove it, one of the largest, of a medium quality, was divided into sections, which, on being analysed, gave the following results:—

| | | |
|---|---|---|
| Exterior | 32·27 | phosphate of lime. |
| | 61·71 | carbonate of lime. |
| Intermediate | 13·87 | phosphate. |
| | 67·14 | carbonate. |
| Interior | 10·26 | phosphate. |
| | 69·17 | carbonate. |

Theoretically this experiment was important, as tending to throw light upon the source of the phosphoric acid so abundantly

* The quantity of fluorine in these different fossils has not in any case been determined. In some instances it is very considerable; and were there any reason to view it as of *agricultural* importance, it would not have been omitted.—[J. T. Way.]

prevalent in these strata, proving satisfactorily that it was external in its origin.

No internal organization of structure is discernible in these bodies. They are intensely hard, and the most difficult of all the fossils to reduce to a fine powder.

Another abundant supply of phosphate of lime is derived from lumps of various sizes, utterly shapeless. These are always of a light reddish-brown colour: when first dug they are very soft, and never attain a greater hardness than that of soft white chalk. Their specific gravity is small compared with the former nodules. In a few instances, specimens have been found which unite the characteristics of both classes; the external portion consisting of the latter. These lumps are invariably rich, as the subjoined analysis indicates: the specimen is from the Dippen Hall pits:—

| | |
|---|---|
| Insoluble silicious matter, with a little clay | 7·18 |
| Soluble silica | 3·28 |
| Organic matter | 2·49 |
| Phosphoric acid (equal to 55·96 of bone-earth phosphate) | 27·13 |
| Carbonic acid | 8 77 |
| Lime | 39·85 |
| Magnesia | ·96 |
| Oxide of iron and alumina | 10·60 |
| Traces of fluorine | — |
| | 100·26 |

But there is another description of organic remains which is found in still greater profusion than any of the preceding. They consist of very dark brown lumps of every form and size; some are microscopically small, others attain the weight of 3 and 4 lbs. each: they are both heavy and hard. It appears that these substances at one period must have existed in a soft plastic state, since many of them are agglutinized to the surfaces of the syphoniæ, corals, shells, teeth, and wood. Some very perfect pectens are covered up, both internally and externally, with these amorphous bodies, which cannot be detached without breaking the shell.

This substance seems to be identical with that which has been designated by Dr. Mantell, in his 'Medals of Creation,' p. 431, as 'Molluskite, or the Carbonized Remains of the soft parts of Mollusca.' In introducing this subject he says,—

"I will offer a few remarks on a carbonaceous substance resulting from the gelatinous matter of which the soft bodies of these animals are composed, and for which I propose the name of *Molluskite*, to indicate its nature and origin.

"This substance is of a dark-brown or black colour, and occurs either in shapeless masses, which are irregularly distributed among the shells

and other organic remains in sandstone, limestone, &c., or as casts of shells, or occupying their cavities. Upon analysis this substance is found to contain a large proportion of animal carbon. The rocks of fire stone at South Bourne, on the Sussex coast, are mottled with brown molluskite and hard amorphous concretions, consisting of carbon and phosphate of lime, mixed with sand and other extraneous matter. Casts of shells, of the genera *Venus*, *Arca*, &c., entirely composed of the same kind of materials, are also abundant in these rocks. The lowermost bed of gault, at its line of junction with the green-sand beneath, at Folkstone and in many other localities, is largely composed of similar matter, resembling in appearance the fossils called *coprolites*, hereafter described. The outer chamber of the ammonites and other shells, so abundant in the gault, are often filled with this substance. But the most interesting deposit of molluskite is in the Kentish rag of Mr. Bensted's quarry, near Maidstone. This phenomenon had not escaped the notice of that intelligent and accurate observer, who liberally placed at my disposal numerous shells, particularly of *Trigoniæ* and *Terebratulæ*, which were filled with molluskite; and large slabs of the sandstone full of concretionary and amorphous masses of the same. The latter, Mr. Bensted suggested, were derived from the fossilized bodies of the dead mollusks, which had become disengaged from their shells, and aggregated together, and had floated in the sea, until enveloped in the sand and mud, which is now consolidated into the arenaceous stone named Kentish rag. Mr. Bensted, in illustration of this opinion, referred me to the following curious fact, related in the 'American Journal of Science:'—In the year 1836 a fatal epidemic prevailed among the shell-fish of the Muskingum River, in the State of Ohio. It commenced in April and continued until June, destroying millions of the mollusca that inhabited the beds of the tributary streams and the river. As the animals died, the valves of the shells opened, and, decomposition commencing, the muscular adhesions gave way, and the fleshy portions rose to the surface of the water, leaving the shells in the bed of the river. As masses of the dead bodies floated down the current, the headlands of islands, piles of drifted wood, and the shores of the river in many places, were covered with them; and the air in the vicinity was tainted with the putrid effluvia exhaling from these accumulations of decomposing animal matter. The cause of the epidemic was unknown. 'Now nearly the whole of the shells in these beds of Kentish rag,' Mr. Bensted remarks, 'have their shells open, as if they were dead before their envelopment in the deposit. And from the large quantity of water-worn fragments of wood perforated with pholades imbedded with them, it seems probable that this stratum had originally been a sand-bank covered with drifted wood and shells, and presenting a very analogous condition to the phenomenon above described.'

"The gelatinous bodies of the *Trigoniæ*, *Astreæ*, *Rostellariæ*, *Terebratulæ*, &c., detached from their shells, may have been intermingled with the drifted wood in a sand-bank; while in some instances the animal matter would remain in the shells, be converted into molluskite, and retain the form of the original."

This very interesting and instructive account of Dr. Mantell's cannot

be dismissed without recommending that it should be turned to profitable use by an examination into the composition of the fossiliferous portion of the Kentish ragstone which is here described.

The fossils discovered by Professor Henslow, noticed above, and the nodules examined nearly 30 years ago by M. Berthier, appear to have been principally composed of this molluskite.

M. Berthier's analyses of them, taken from a rock of the green-sand at Havre, through which they were disseminated, gave—

| | |
|---|---|
| Phosphate of lime . . . . | 57 |
| Carbonate of lime . . . . | 7 |
| Carbonate of magnesia . . . | 2 |
| Silicate of iron and alumina . . | 25 |
| Water and bituminous matter . | 7 |
| | 98 |

Having thus recorded the results of examinations made upon the characteristic types of the fossils of the upper green sand phosphoric beds, it is necessary to proceed to the investigation of the component parts of the aggregate masses and of the soil which envelops them; and also to describe the method which has been adopted in digging and preparing them for use. This portion of the inquiry is in fact the most important in its agricultural bearings.

From one of the pits on Dippen Hall farm, a mass weighing 30 lbs. was indiscriminately taken out of a rich fossiliferous vein. This mass was thoroughly washed, and the fossils carefully separated; these were of all sorts and sizes, amounting to 61 per cent. of the whole: 10,000 grs. weight of them were broken, and they gave an average composition of—

| | |
|---|---|
| Insoluble silicious matter . . . | 9·84 |
| Soluble silica . . . . . . | 2·36 |
| Organic matter . . . . . | 3·26 |
| Phosphoric acid (equal to 59·60 of bone-earth phosphate) . . . . . | 27·60 |
| Carbonic acid . . . . . | 6·96 |
| Lime . . . . . . . | 44·56 |
| Magnesia and loss . . . . . | ·81 |
| Oxide of iron and alumina . . . | 4·61 |
| | 100·00 |

The residuum of marl washed off from the fossils, when dried, gave—

| | In coarse particles. | In fine mud. |
|---|---|---|
| Insoluble silicious matter . . . | 21·85 | 26·25 |
| Soluble silica . . . . . . | 20·18 | 18·11 |
| Organic matter . . . . . . | 6·25 | 5·95 |
| Carried forward . . | 48·28 | 50·31 |

| | In coarse particles. | In fine mud. |
|---|---|---|
| Brought forward | 48·28 | 50·31 |
| Phosphoric acid | 7·80 | 10·38 |
| Carbonic acid | 10·91 | 10·34 |
| Lime | 20·58 | 19·87 |
| Magnesia | 1·59 | ·87 |
| Oxide of iron and alumina | 8·18 | 6·18 |
| Potash and soda not estimated. | — | — |
| | 97·34 | 97·95 |

About 30 or 40 tons of this phosphoric marl have been dug upon Dippen Hall this spring for the purpose of agricultural experiments. The plan adopted in digging was to fill the richest portions of the marl into bags (the very large fossils being picked out) ; it was then carted to the farm and placed under cover: it has since been sifted, after it became dry enough for that purpose. The portion of the marl which passed through the sieve (all the fossils having been first separated from it) gives on analysis—

| | |
|---|---|
| Insoluble silicious matter | 32·81 |
| Soluble silica | 29·14 |
| Organic matter | 3·02 |
| Phosphoric acid (equal to 13·63 bone-earth phosphate) | 6·61 |
| Carbonic acid | 2·30 |
| Lime | 9·53 |
| Magnesia | 1·97 |
| Oxide of iron and alumina | 11·46 |
| Potash | 3·10 |
| Soda (none). | — |
| | 99·94 |

The part retained upon the sieve, being about two-thirds of the whole quantity, consisted of indurated pieces of marl and small fossils imbedded in it. This, when sufficiently dried, was ground up in a mill erected for the purpose. The average of this mass contains—

| | |
|---|---|
| Insoluble silicious matter | 26·83 |
| Soluble silica | 26·30 |
| Organic matter | 2·64 |
| Carbonic acid | 2·35 |
| Phosphoric acid (equal to 19·22 of bone-earth phosphate) | 9·31 |
| Lime | 15·24 |
| Magnesia | 1·43 |
| Oxide of iron and alumina | 13·11 |
| Potash and soda not estimated. | — |
| | 97·21 |

The large hard fossils are first broken with stone-hammers, in a similar way to that in which gravel is prepared for road-making, and then reduced to powder by the mill; they, however, require to be passed through the rollers two or three times.

In any of the above states the prepared marl is fit to be applied to the land by the drill, or to mix with ammoniacal manures.*

The mill is attached to the machinery of a small threshing-machine; it consists of two pairs of cylinders, the upper ones being fluted transversely. Scrapers like those used in a common bone-mill are indispensable. Two horses will grind up from 2 to 5 tons a-day, according to the hardness of the substance.

Much trouble and expense would have been saved had the marl been dug in the summer months, as it might then have been dried in the sun before it was housed. The expense of procuring this marl, when it lies near the surface in tolerable thickness, is of course very trifling: the refuse, that is the upper and lower portions of the bed not considered worth the trouble of subsequent preparation, if carted away in the gross to be spread from the cart upon land requiring phosphatic manure, would pay all the expenses.

It is difficult to estimate the quantity of the phosphoric marl to be obtained in the parish of Farnham, but many thousand tons might certainly be dug.

In the adjoining parish of Bentley, which lies west of Farnham, very large quantities of a similar description of marl may be procured. In the pits which have been examined the fossils are not so numerous as at the latter place, but the average composition of the marl, and the character and chemical properties of the fossils, are identical.

Some of the beds have been evidently worked for agricultural purposes at a former period, as is shown by the remains of partially filled-up pits; near them also are now lying heaps of the larger fossils, which were then rejected as useless. This conclusively proves that the agricultural value of this peculiar soil is no novelty, although the cause of its fertilizing powers was previously unknown. There is evidence indeed to show that this selfsame marl, about 60 years ago, was carried into Sussex as a manure—the distance being upwards of 20 miles. All the resident farmers unanimously testify to the extraordinary fertility of the green band whenever it appears near the surface.

Analyses of this marl, with a few fossils broken up with it, and of the fossils themselves, are here introduced:—

---

* The whole class of the green-marl fossils, when rubbed together, or ground up in the mill, emit a strong, disagreeable, fetid smell. This is a phenomenon dependent upon their chemical composition, which, however, it would not be right to discuss here.

| | The marl, including fossils. | The fossils. |
|---|---|---|
| Insoluble silicious matter | 39·59 | 7·12 |
| Soluble silica | 18·42 | 3·27 |
| Organic matter | 4·12 | 3·04 |
| Phosphoric acid | 6·89 | 33·03 |
| Carbonic acid | 4·52 | 5·58 |
| Lime | 9·11 | 46·50 |
| Magnesia | 1·64 | traces. |
| Oxide of iron and alumina | 13·55 | 1·96 |
| | 97·84 | 100·50 |

It has been already stated, that in the layer of rubbly broken-up rock upon which the green marl immediately rests, very great quantities of a purely white soft substance are interspersed. This substance, both at Bentley and at Farnham, frequently assumes the form of the large spongoid transition fossils previously described; it is composed of

| | |
|---|---|
| Insoluble silicious matter | 16·82 |
| Soluble silica | 12·92 |
| Organic matter | 2·29 |
| Phosphoric acid | ·78 |
| Carbonic acid | 22·54 |
| Lime | 34·68 |
| Magnesia | 1·01 |
| Oxide of iron and alumina | 6·29 |
| | 97·33 |

After leaving Bentley, in proceeding in a S.W. direction, the phosphoric band may be traced to Froyle, in which parish it crosses the Southampton road; it then continues with the same bearing till it crosses the river Wey, below Alton, and is traceable, though occasionally much obscured by diluvial detritus, to Worldham. Here there is an immense longitudinal quarry, about 15 feet in depth, from which, at some remote period, thousands of loads have been removed. This quarry has recently been reopened by the present proprietor, in consequence of his having carted a few loads by way of experiment upon some adjacent pasture-land, where the benefit arising from its application was most perceptible, especially in developing a good herbage of clover. A small quantity was also taken to another part of the estate about a mile distant, and was put upon an arable field; but in this case no advantage accrued. A recent examination of this field demonstrated the cause of the failure by indicating the presence of the identical phosphoric band in the subsoil lying immediately below the spot where the marl was applied. The proprietor also mentioned a circumstance which occurred upwards of 20 years since, when some of the marl from the above pit was carted away to a neighbouring farm. The waggon once broke down, and its contents were thrown upon an adjoining field and spread very thickly over a small space; the spot was noticed during many successive years on account of the superiority of the crops which grew there; yet, strange to say, this evidence was practically disregarded!

The fossils of this marl, though less numerous, are similar to those at Farnham; exclusive of them the marl itself contains a percentage of

| | |
|---|---|
| Carbonate of lime . . . . | 25·72 |
| Phosphate of lime . . . . | 14·92 |
| Potash . . . . . . | 2·69 |
| Soda . . . . . . | ·50 |

The phosphoric green band is prolonged in the same S.W. course, following the curve formed by the interior of the basin at the junction of the North and South Downs. The strata here, however, have not yet been minutely examined, nor have analyses been made in reference to the determination of the presence of phosphatic matter: but a geological friend, writing in allusion to this subject, says, "I observed, some years ago, numerous fossils, fruits among others, in a bed of the genuine upper green-sand, exposed in a fresh-cut road leading from East Meon towards Petersfield."

In the Isle of Wight the phosphoric marl of the upper green-sand is extensively developed: it is found in enormous quantities at the back of the island, especially at the top of the Undercliff, where it may be traced for several miles, lying within a few feet of the surface. The thickness of the band varies from 3 to 7 and 8 feet; it is therefore easily attainable. Organic remains abound, particularly ammonites and sponges; the analyses of which, as also of the marl, are very similar to those of the Farnham beds. Here likewise the large spongoid bodies are very numerous, which are characterized by the usual peculiarities.

Near Sutton Waldron, in Dorsetshire, the upper green-sand covers a wide expanse. Its junction with the soft dirty-white marl above is well defined, but in other respects it differs from the correlative strata of Kent, Surrey, and Hampshire. In some places the marl degenerates into a pure sand, which is sufficiently arenacious to be used for making mortar. It contains comparatively but a very trifling quantity of phosphoric acid, whilst the chief constituent of its fossils, which are numerous in some parts, is carbonate of lime. In one field, however, some casts of small ammonites were found which contained a high percentage of phosphates: the neighbourhood is, therefore, well worthy of a fuller investigation.

At Mintern, on the contrary, both the marl and its fossils are of a richer character. A partial analysis of them gave, in a

| | |
|---|---|
| Speckled marl:— | |
| Silica (soluble and insoluble) . . . | 26·68 |
| Phosphate of lime . . . . . | 11·04 |
| Carbonate of lime . . . . . | 49·25 |
| A green-sandstone:— | |
| Phosphate of lime . . . . . | 6·07 |
| Carbonate of lime . . . . . | 52·06 |
| Fossils in a brown marl:— | |
| Phosphate of lime . . . . . | 46·74 |
| Carbonate of lime . . . . . | 18·47 |
| In the marl:— | |
| Phosphate of lime . . . . . | 9·10 |
| Carbonate of lime . . . . . | 4·13 |

This marl is extremely rich in fossil remains, amongst which a species of small scaphites are very numerous.

The phosphoric fossils of the upper green-sand have also been found as far west as at Chard in Somersetshire.

They were found to contain—

| | | |
|---|---|---|
| Phosphoric acid . . | 10·16 | per cent. |
| Equal to | 20·97 | bone-earth phosphate. |

The fossil phosphates from the gault require little further notice, as they have hitherto been found only thinly scattered through the mass of clay. Dr. Fitton, in the Memoir quoted above, mentions that at Ridge in Wiltshire, and at Mildenhall in Suffolk, he found ammonites, &c. in conjunction with coproid concretions of phosphate of lime (pp. 247, 312).

This stratum has been examined in different parts of the kingdom, in order to ascertain if a sufficient supply of fossils existed which might be profitably collected for agricultural uses. In all cases the analyses of the fossils showed them to be extremely rich in phosphoric acid; but nowhere do they seem to exist in quantities large enough to pay the expenses of digging for them. The most common fossils are ammonites, oblong reniform masses, containing no specific organic remains (the coproid bodies of Dr. Fitton), and indurated wood.

The following is an analysis of a large gault fossil from Farnham:—

| | |
|---|---|
| Insoluble silicious matter . . . . | ·91 |
| Organic matter . . . . . | 2·94 |
| Carbonic acid . . . . . | 12·43 |
| Oxide of iron . . . . . | 2·91 |
| Lime . . . . . . . . | 47·46 |
| Magnesia . . . . . . | ·21 |
| Phosphoric acid . . . . . | 24·28 |
| Water, fluorine, and loss . . . | 8·86 |
| | 100·00 |

The lower green-sand, taken as a whole, differs so widely in its agricultural value, that any general description of its character would be utterly useless. In the first instance, therefore, attention will be exclusively confined to the fossiliferous bed of the upper part of this formation. This bed has been found to be so invariably persistent in its prominent features in localities widely separated from each other, that it is most important to bear in mind its exact geological position, viz. *just below the gault, at its junction with the lower green-sand.* Another distinctive mark is, the usual accompaniment of a thin seam of iron-sandstone, to which a few scattered fossils often adhere. This band and the conglomerated fossils so completely obstruct the downward pas-

sage of water, that drainage is rendered indispensable whenever they happen to occur near the surface in cultivated grounds; and the springing out of water on the side of a hill has frequently indicated the presence of the bed, when it had been superficially covered up by drift.

Dr. Fitton again specifically mentions the occurrence of this bed in his memoir at pages 111, 116, 117, 145, 157, 181, and 209. He describes these fossils as nodules and irregular masses which resemble coprolite in their chemical composition, though no traces of animal structure are apparent in them. Others are of irregular figure, surrounding or incorporated with fossil remains, especially of ammonites, the interior of which is filled with matter of the same kind—all containing phosphate of lime.

Dr. Mantell also, in his 'Geology of the S.E. of England,' says, at page 172—"At about three miles N.W. of East Bourne the green (lower) sand is covered with a thin layer of gault, which occurs immediately beneath the surface; the sand abounds with rounded fragments of coniferous wood that occur on the road side, near the Folkington road. The specimens are incrusted with a covering of grey sand containing small pebbles of quartz, and internally are of a reddish-brown colour. The wood is calcareous, and bears a good polish, the transverse sections displaying, in a distinct and beautiful manner, the radial insertions and annular markings which denote the annual growth of the tree," &c. &c.

This description so minutely agrees with the appearance of the phosphoric bed as found elsewhere, that there is scarcely a doubt of its identity. It is highly probable, too, that the fossil wood, if analysed, would be found richly phosphoric, not carbonic.

Again, taking the Farnham beds as a type and illustration of the entire range, the particulars there noticed are recorded below. The general mass of soil in which the fossils are imbedded in this stratum differs essentially from the phosphoric marl of the upper green-sand, inasmuch as the enveloping marl of the latter largely partakes of the phosphoric nature of the fossils, whilst the former seems to be destitute of it, excepting that which is derived from the decomposition of the fossils. The following is an analysis of a mass, from which the principal fossils had been picked out:—

| | |
|---|---|
| Insoluble silicious matter . . . . | 75·46 |
| Soluble silica . . . . . . | 8·12 |
| Organic matter . . . . . . | 2·30 |
| Phosphoric acid . . . . . . | 0·64 |
| Carbonic acid . . . . . . | 5·64 |
| Lime . . . . . . . . | 2·01 |
| Magnesia . . . . . . . | 0·18 |
| Oxide of iron and alumina . . . . | 5·59 |
| | 99·94 |

On the east of the town of Farnham, near Bourne Mill (this

place was indicated by Dr. Fitton, p. 145), there is an insulated outlier of the lower part of the gault, where, at its junction with the sand, is a very rich bed of fossils. This spot of land a few years since was waste common; it was enclosed, and is now occupied by a labourer. It was always considered to be a piece of worthless unreclaimable land. It has been well trenched up, and the occupier collected some of the fossils, which he pounded to pieces and strewed the fragments over the land. It is now sown with wheat, which presents a very flourishing appearance. On the west of the town, and on the north side of the Southampton road, leading to Bentley, the only opportunity afforded to examine the subsoil are some deep ditches and water-worn gullies; but here, at the junction of the two strata, the fossil beds are always found. On the opposite or south side of the River Wey, above the new church, in the village of Wrecklesham, there is an outcropping of the gault, below which are some very conspicuous beds of phosphates. At this place a pit has been opened in search of them, or, more correctly, the outcrop on the side of the hill has been worked into. There are three distinct beds of fossils: the first lies above the thin seam of ironstone; it is about three or four feet thick, the fossils being intermingled in a soft matrix of sand and clay. This bed has been wholly carted away, as it was dug to be applied to a neighbouring field of a loose gravelly texture; this was done because the fossils could only be obtained by the tedious process of hand-picking. It may be, perhaps, worth while to remark, that this portion had occasionally been carted on the land before, and always with marked benefit. This good result may be partly attributed to the facility with which many of these fossils decompose when exposed to the alternations of weather, because the fossils in the upper stratum are seldom as much indurated as those in the lower beds, and, being also less intermingled with sand, they contain a higher percentage of phosphoric acid.

The position of the second bed is immediately below the ironsandstone. It consists almost entirely of a conglomerate of fossils in a matrix of sand, which is from 3 to 18 inches thick. The third bed lies about 3 feet lower, and is similar in all respects; occasional fossils are mingled with the intervening layer of sand. The fossils in all these beds possess the property of binding the sand together like masses of indurated mortar, the phosphate of lime acting as a cement.

From the second bed a solid lump of the conglomerate weighing 60 lbs. was taken; which, after being broken up and sifted, and the fossils washed, yielded 35 per cent. of them. The whole of the fossils, powdered, but not dried, gave, on analysis—

| | |
|---|---|
| Insoluble silicious matter | 43·87 |
| Soluble silica | 3·25 |
| Organic matter, water, and fluorine | 3·44 |
| Phosphoric acid (equal to 42·48 of bone-earth phosphate) | 20·80 |
| Carbonate of lime | 1·06 |
| Lime in combination with phosphoric acid | 23·86 |
| Oxide of iron and alumina | 3·35 |
| Magnesia and loss | 0·37 |
| | 100·00 |

Another outcrop has been followed out in the commons at a spot distant about half a mile S.W. from the above pit; but here there is only one bed beneath the iron-sandstone. On digging the fossils the mass is broken to pieces with a pickaxe and passed through a half-inch sieve; just in the same manner as gravel is obtained for road-making. When the fossils become tolerably dry, they are then passed over a finer sieve, which gets rid of the greater part of the loose adhering sand. About twenty tons of clean fossils have been dug from these two sites, at a cost of fifteen shillings per ton.

The fossils are easily ground up into powder between cylindrical rollers. The same mill is employed to grind the fossils both of the upper and lower green-sand. If a higher percentage of phosphate of lime were required for any particular purpose, it might be raised to about 55 or 60 per cent. by a subsequent process of sieving, which separates the coarser grains of sand from the powder. It is worthy too of special remark, that the fossils of these lower green-sand beds contain scarcely any carbonic acid.

With the more definite fossils are intermixed masses of a brownish-coloured wood, in most instances bored by teredines; there are also many round or oblong nodules without definite fossils, the form of which was probably determined by the littoral action of the waves on a former sea-beach. These nodules, on being fractured, exhibit in the middle a yellow-reddish tinge, somewhat similar in appearance to the interior of the so-called Suffolk coprolite. No organic structure has been detected in the majority of them, though some of them contain fragments of ammonites, &c. Some are not larger than hazel-nuts, others weigh three or four pounds each. Associated with the fossils are also many irregularly shaped masses not at all water-worn; these appear to have been derived from the decomposition of the fossils, and the phosphate of lime has recombined with the surrounding sand, forming lumps very like pieces of coarse mortar.

On the western side of the parish of Frensham there is a continuation

of the fossiliferous strata, skirting the edge of the Alice Holt Forest. The fossils in this locality are chiefly confined to the upper bed at the immediate junction of the sand and gault clay; they are similar in character to those found at Wrecklesham, but the nodules are generally larger, many of them being of the size of a man's fist.

At present there are but few facts extant which bear upon the agricultural properties of these fossils; yet the few which have been noticed are strikingly illustrative of their value as fertilizers. In the parish of Frensham, about ten or fifteen years ago, the late proprietor of one of the fields where the fossils abound was in the practice of carting away, at leisure times, very large quantities of the lower part of the gault clay embracing the fossil bed; it was taken to another part of the farm where the land is of a sandy nature. Upon the crops in succeeding years the good arising from the application of this soil was evident at a glance. The proprietor was induced to cart this soil upon his other land on account of the numbers of fossils which it contained, he then supposing they were rich in *carbonate* of lime. Distance prevented the cartage being continued to a much greater extent.

A second instance occurred in April, 1847, when, in making some drains in a field in which the water occasionally rose to the surface in very wet weather, after digging through a layer of hard shingly gravel to the depth of between five and six feet, a thin indurated bed of mortar-like stuff was found, which effectually resisted the downward progress of the water. It was about six inches thick, resting upon dry sand. This mortar-like stuff was at that period suspected to be of coprolitic origin, and the men employed in draining were directed to spread it carefully over the surface about half a rod wide on the lower side of each drain. It need scarcely be observed after the above description, that soil in its natural state is one of the very poorest; yet upon these strips of land below the drains many of the Swede turnips with which the field was sown last year, in spite of the unfavourable season, attained a weight of from 15 to 20 lbs. each.

The indurated band found at the bottom of the drains is the correlative of the lower Wrecklesham bed, the overlying gault having been denuded at some former geological epoch, and subsequently replaced by the drifted gravel of a more recent period. It may be also advisable to state, as an indication of the fertilizing properties of these fossils in their unprepared condition, that in digging for them in the commons the upper and softer fossils were invariably found to be enveloped with a thick fibrous network of the small rootlets of the furze and other plants which grew above them; and that, whenever a crack occurred in a fossil, the spongioles had insinuated themselves into it, just in

the same manner as is often seen in the case of an old bone which has been buried. This was noted in many places where there was an outcropping of the fossil beds by the side of cuttings in lanes, &c.

After leaving the parish of Frensham and proceeding westward through the parish of Kingsley, the fossiliferous beds are exposed in the fields lying below the talus of the escarpment of the fire-stone rock to the neighbourhood of Petersfield. In many of the fields the gault clay is denuded, and the fossils can be obtained in considerable quantities a foot or two below the surface. In fact, over an area of several acres the fossils are exposed on the surface, having been brought up by ploughing, trenching, and draining. A good many tons, now lying upon the ground, might be picked up at a trifling cost. All the specimens obtained in this quarter exhibit a very large amount of phosphoric acid.

It is also worthy of notice that most of the land selected for the growth of hops in this district is situated upon the stratum of fossils. The farmers too in the neighbourhood uniformly agreed in remarking that these fields were their most productive ones, both in hops and corn.

At Folkstone, in Kent, the natural sections exposed on the face of the cliff present many facilities for examining this peculiar bed of fossils. They are here found in a solid conglomerate rock, from one to two feet thick, the whole of which is more or less phosphatic. This band commences on the east of the town, at the top of the cliff, where it lies close to the surface. As the strata here dip towards the east, the bed is easily recognised in its usual position just below the dark-blue gault clay, until it finally disappears on the sea-beach opposite the Martello tower No. 1. Large masses of the conglomerate have fallen from the cliff, and now lie upon the rocky shore below; they are of all sizes —some of the blocks would probably weigh nearly half a ton. They are chiefly composed of various shells, ammonites, and fossil wood, mixed with sulphuret of iron and gypsum; the latter substance constituting the principal part of the matrix. One of the amorphous nodules without organic remains (analogous to those described above as found at Wrecklesham), when broken up, give on analysis the following composition:—

| | |
|---|---|
| Silica and sand | 13·64 |
| Sulphate of lime | 50·16 |
| Water in combination | 14·97 |
| Water (accidental) | 7·47 |
| Phosphoric acid | 4·80 |
| Lime, additional | ·27 |
| Oxide of iron and alumina | 8·82 |
| | 100·13* |

With traces of fluorine.

* The chemical reader will understand that in this case the phosphoric

But when this fossil bed dips into the sea (unless, indeed, as is suspected, it be a second and lower one, similar to some strata afterwards found in this geological position in the Isle of Wight), the proportion of phosphoric acid is much greater, being 25·27 per cent., or equal to 52·17 of the phosphate of lime.

On the west of Folkstone the bed is seen opposite the church at the top of the cliff, with which it runs parallel, about 3 or 4 feet below the surface, for a considerable distance towards Sandgate. The fossils here are in a matrix of loose loamy sand, and are in every respect similar to those found in the neighbourhood of Farnham.

In the Isle of Wight, from Culver Cliff to Atherfield Point, wherever a junction of the gault with the lower green-sand has been examined, the phosphoric fossil beds have been discovered. The fossils in character and composition are identical with those of Farnham, and therefore need no further description. Only one exception was noted, which occurred in the ravine at the top of Shanklin Chine, where all the fossils of the junction were almost wholly composed of the sulphuret of iron.

On the beach at Shanklin, Luccomb, Ventnor, &c., very many tons of these fossils might be picked up at low-water for less expense than the cost of gathering the lumps of sulphuret of iron, which is understood to be five shillings per ton. Amongst the fossils there are large quantities of black fossil wood, frequently encrusted with a grey cement of phosphate of lime and sand. This wood is very rich in phosphoric acid.

It is very probable that the fossil forest imbedded in the Wealden clay at Brook Point is impregnated with phosphoric, instead of carbonic acid, as is generally assumed. In appearance the wood is similar to that which was analysed above.

The strata of the lower green-sand below the *junction* beds have not yet been carefully investigated for the purpose of discovering phosphoric remains. A few cursory observations, however, have been made. At Folkstone there are huge masses of rock lying upon the beach, which consist of a conglomerate of unusually large grains of green-sand thickly interspersed in a matrix of a greyish colour; this rock, when broken up, contains, amongst other matters not estimated, a percentage of—

| | |
|---|---|
| Insoluble silicious matter | 30·60 |
| Phosphoric acid | 7·23 |
| Potash | 3·31 |
| Soda | 1·02 |

The large green grains are readily separable from the matrix

acid could only have existed in combination with oxide of iron, the lime being united with sulphuric acid, and really being present as gypsum, since it was all dissolved out by water in the analysis.—[J. T. W.]

in which they are imbedded. They were analysed, with the following results* :—

| | |
|---|---|
| Soluble and insoluble silicious matter | 18·53 |
| Water | 2·28 |
| Phosphoric acid | 20·65 |
| Carbonic acid | 4·01 |
| Sulphuric acid | 5·13 |
| Lime | 34·61 |
| Oxide of iron | 7·24 |
| Alumina | ·98 |
| Potash | 1·79 |
| Soda | 1·87 |
| | 97·09 |

* These green grains are very interesting: from their form and colour, in both of which respects they closely resemble the green particles of the *true* "green-sand," it is impossible to resist the impression that their formation is in some way connected with these latter. By way of comparison a partial analysis was made of some of the *small* green grains, picked grain by grain from a speckled marl before mentioned. The results were as follows:—

| | |
|---|---|
| Insoluble silicious matter | 45·02 |
| Phosphoric acid | 5·71 |
| Lime | 13·16 |
| Oxide of iron | 13·42 |

Here too it would seem that these green grains *may* contain a considerable percentage of phosphoric acid.

Such is not, however, always or necessarily the case, for in several instances the very greenest specimens have been examined for phosphoric acid, and have been found to contain scarcely any; thus an exceedingly green sand from Chard contained only ·069 per cent. of phosphoric acid, equal to ·142 per cent. of bone-earth. It is certainly not quite clear that the green grains may not have *originally* contained phosphoric acid in *all cases*, for it is observed that wherever this ingredient is wanting the grains have a lighter colour and a less compact structure, and are often broken up into a finely comminuted green powder, which will remain for many hours suspended in water. This effect may be due to a weathering, in the course of which the phosphoric acid is more or less removed, and it may be produced artificially by digesting the grains in dilute hydrochloric acid, which readily removes the phosphate of lime without destroying their form.

The same remarks apply to the different results which have been obtained by various chemists in regard to potash as an ingredient of the green-sand. In some cases only traces of this alkali have been detected—in others as much as 10 or 12 per cent. has been found. It must be borne in mind that what is usually called "*green-sand*" is a variable mixture of green grains with pure white particles of quartz, and that the latter form by far the largest proportion —the green colour of the real particles being so intense as to exhibit itself when largely diluted.

In the green-sand from Chard just described, the following quantities of the alkalies were found:—

| | |
|---|---|
| Potash | 0·129 per cent. |
| Soda | 0·121 per cent. |

—the sand being fused with barytes.

In the Isle of Wight, between Black-Gang Chine and Atherfield, many of the masses of fossiliferous rocks are more than ordinarily phosphoric, but, as they frequently contain a large proportion of the carbonates of iron and lime, they do not afford a high percentage. There are, however, some exceptions, amongst which may be particularized the blocks of fossils in the scaphite, the lower crioceres, and the second gryphæa beds; besides the casts of ammonites and scaphites which lie upon the beach. The specimens which have been examined show them to be very rich in phosphatic matter.

There is ample room in this locality for a diligent search after phosphate of lime, with a good prospect of obtaining large quantities. Such an investigation would be greatly facilitated by consulting Dr. Fitton's 'Stratigraphical Account of the Section from Atherfield to Rocken End,' published in the third volume of the Quarterly Journal of the Geological Society of London.

The constant occurrence of the beds of phosphoric marl and fossils in the upper green-sand above the gault, and of the fossils in the lower green-sand below the gault, at places very remotely distant from each other, seems to indicate a general fact, that at certain geological epochs a vast deposition or outpouring of phosphoric acid took place; and consequently, it is fair to presume that the strata above described, which are the records or present representatives of those epochs, would *everywhere* afford these phosphatic remains.

In the foregoing pages an attempt has been made to describe the *present condition* of certain deposits of phosphate of lime, and, in so doing, speculation as to the *origin* of this substance has been kept in the background—it being the wish of the writers to render their account as simple and *useful* as possible. Whence and in what manner the phosphoric acid found its way into fossils, which are usually composed of carbonate of lime or of silica, are certainly questions of very considerable interest both to the geologist and chemist, but can hardly be said to affect the *agricultural* reader. That the phosphate of lime has penetrated the various fossils and nodules *from without*, there scarcely exists the smallest question; and were it possible that it had been primarily derived from some *true mineral deposit* (like that of Estremadura), the circumstance might stimulate to increased search after so invaluable a treasure. But there is every reason to believe that this vast quantity of a substance which is by no means superabundant on the surface of our planet is to be ascribed to the presence, at some epoch of its existence, of a very great amount of animal life which served as the means of its concentration.


Geological Map
OF THE
EAST RIDING
OF
YORKSHIRE
Diluvial
Kimmeridge Clay
Coralline Oolite
Oxford Clay
Kelloways Rock
2
Inferior Oolite
Lias
1
New Red Sandstone
variegated Marls
3
Chalk
Filey
Speeton
Hunmanby
Sherburn
Ganton
Flamborough Head
Helperthorp
Kirby Grindalyth
Malton
Settrington
Rudstone
Bridlington
Quay
Sledmere
Westow
Birdsall
Wharram Percy
Kilham
Burton Agnes
Acklam
Kirby Underdale
Driffield
Barmston
Bp Wilton
Stamford Br
Huggate
Skipsea
Fangfoss
YORK
Bainton
Warter
Pocklington
Elvington
Sutton on Derwent
Brandes Burton
Hornsea
Wheldrake
St Dalton
Escrick
E Cottingwith
Rise
Beverley
Aldbrough
Newbald
Helme on Spalding Moor
R Derwent
Riccall
Bubwith
Cottingham
Selby
Wressle
Brantingham
Elloughton
HULL
Hedon
Rooss
Withernsea
Howden
Hessle
Brough
Patrington
Easington
Sunk Island
Scale of Miles
Spurn Point

## V.—*Farming of the East Riding of Yorkshire.*
By George Legard.

### Prize Report.

The East Riding of Yorkshire comprises the south-eastern portion of that county; and, unlike the majority of English counties, is, with the exception of a few miles, defined by an entirely natural boundary. The German Ocean flanks it on the East; the rivers Harford, Derwent, and Ouse surround it on the north and west; and the last river, uniting with the Humber, forms its southern limit. The only break in this natural boundary, as will be observed in the map, occurs on the west side of the Riding, where the boundary-line leaves the river Derwent at Stamford Bridge, and runs for 8 miles along an ancient Roman road from that place to the city of York. There is also a very short interruption in the north-eastern corner, where an unimportant streamlet of a mile and a half in length falls eastward from the watershed of the Vale of Pickering into Filey Bay, and divides the North from the East Riding.

The East Riding is the least of the three divisions of the county, both in area and population. It consists, by computation, of 711,000 acres, and its population in 1841 was 194,936.

Its topographical features, as well as its geological construction, seem to require that it should be separated into three districts, which may be described as—1st, *The Wold district,* occupying the central high ground of the Riding; 2nd, *Holderness,** stretching out in a south-easterly direction from the Wold Hills to Spurn Point; and 3rd, *The Vale of York,* extending from the western escarpment of the Wolds to the rivers Derwent and Ouse.

*Of the Wolds.*—The chalk Wolds of Yorkshire exhibit the same characteristics as distinguish this particular formation in other parts of the kingdom. Their rounded uniform outline forms a strong contrast to the nearest neighbouring range of hills, viz. the oolitic, which lie to the north-west. Professor Phillips, in his Geology of Yorkshire, describes the Wold thus:—

"High and bare of trees, yet not dreary nor sterile, they are furrowed, as all other chalk hills, by smooth, winding, ramified valleys, without any channel for a stream. Where several of these valleys meet, they pro-

* In reality the division of Holderness is bounded by the river Hull and by Earl's Dike, but, for the purposes of this Report, it has been found necessary to extend it agriculturally rather more widely, both on the west and north sides. The term Vale of York also applies, strictly speaking, to a much more extensive area, and is used generally to designate a tract of country 60 miles long by 20 wide, and which runs through the centre of Yorkshire, from Thirsk to Bawtry.

duce a very pleasing combination of salient and retiring slopes, which resemble on a grand scale the petty concavities and projections in the actual channel of a river. No doubt these valleys were excavated by water, but not by the water of rains, or springs, or rivulets. Some greater flood in more ancient times has performed the work, and left the traces of its extent in the pebbles which it has deposited along its course."

The area occupied by the chalk hills in this Riding may be illustrated by comparing it to the letter L inverted, in Roman

character, placed rather obliquely, the upper limb representing the northern division, or high Wolds, which extend from Acklam Brow to Flamborough Head, a distance of 30 miles; the stem indicating a tract of land which may be termed the lower Wolds, and which extends from somewhere near Huggate to Hessle, in a south-easterly direction, being about 29 miles long by 5 or 6 broad. The outer sides of the diagram correspond in some degree with the abrupt escarpments of these hills on their north and west sides—the one towards the Vale of Pickering, the other towards the Vale of York; whilst in the angle formed by the limb and stem may be imagined the surface of the chalk gradually sloping towards the south-east, until it dips altogether beneath the diluvial soils of Holderness.

These hills attain their highest elevation at Bishop Wilton Beacon, where they are 812 feet above the level of the sea; from this point southward they gradually decrease in height, until at Brantingham, the southernmost brow of the Wolds in Yorkshire, they do not exceed 500 feet. Throughout the whole of the high Wold district the elevation of the summits of the hills is pretty uniformly maintained; the dip, however, of the strata is to the east, and is stated by Professor Phillips to be about 16 feet per mile. This high district may be generally described as consisting of two or three long parallel ridges, running east and west, having on their summits a considerable breadth of flat table-land. Upon these elevated plains there is uniformly found a covering of diluvial matter from 18 inches to 2 feet in thickness; which consists of a deep and dark-coloured loamy soil, occasionally having an admixture of clay. The soil of the lower Wolds answers tolerably well to the description given by Henry Strickland, Esq., who published 'A Survey of the East Riding of Yorkshire, by order of the Board of Agriculture,' in the year 1812. He says (p. 14)—

"The soil of the wolds is with little variation a light, friable, calcareous loam from 3 to 10 inches in depth."

Marshall, who in the year 1788 published a work entitled 'The Rural Economy of Yorkshire,' says (vol. ii. p. 244)—

"The material which forms the natural construction of the Yorkshire wolds is probably a uniform rock of hard chalk, rising in most places to near the surface.. ........The prevailing soil is a calcareous loam, varying in depth and productiveness."

Recent researches have shown that the soils resting upon the chalk do not partake so much of the nature of the rock beneath as was formerly thought. An analysis made by Mr. Spence, of York, and published in the 'Transactions of the Yorkshire Agricultural Society' in the year 1841, proves that 5 per cent. of calcareous matter is the utmost that these soils contain, and some of them little more than 2 per cent.* The theory of their origin is thus explained by the Rev. Mr. Thorpe in these Transactions (p. 41):—

"In fact, the reason of the variety of the soil of the wolds is easily explained by a consideration of the diluvial beds of Holderness, which lie upon the chalk; enormous masses of water have brought these beds of clay and boulders, not only over the Penine chain of England at Stainmoor, but over the Hambleton hills and western escarpment of the wolds, furrowing the latter into deep east and west valleys—the degree of inclination of the chalk determining the velocity of these currents, and, together with it, their motive power. Upon the more level and elevated portions their influence has been feebly exerted, and the original débris of flints yet remains as the basis of the soil of the deep wold land; but upon the more inclined portions, not only has the original débris of flints been removed, but along with it great bodies of chalk, and by the degradation of the rock thus laid bare the present soil of the shallow wold land is formed. Indeed, the position of the shallow wold land, which is often found reposing at the steep angle of 30° upon the sides of the valleys, affords an additional proof of its being the result of the decomposition of the chalk rock, for it cannot in these localities be a sedimentary, neither is it a portion of any of the tertiary beds which may formerly have existed."

Although it is stated that deep soil is chiefly a characteristic of

---

* Wold Soils analysed by Spence.

| | Deep Wold, Riplingham. | Shallow Wold, Bishop Wilton. |
|---|---|---|
| Water of absorption | 4 | 9 |
| Matter soluble in water | 1 | $\frac{7}{10}$ |
| Matter destructible by heat (*vegetable*) | 5 | 10 |
| Silicious sand | 74 | 62 |
| Alumina | $3\frac{3}{10}$ | 4 |
| Oxide of iron | $6\frac{5}{10}$ | $6\frac{4}{10}$ |
| Carbonate of lime | $2\frac{9}{10}$ | 5 |
| Phosphate of lime | $\frac{4}{10}$ | $\frac{1}{10}$ |
| Carbonate of magnesia | 1 | $1\frac{6}{10}$ |
| Potash | $\frac{6}{10}$ | $\frac{1}{10}$ |
| Loss | $1\frac{4}{10}$ | 1 |
| | 100 | 100 |

the high wolds, yet in the lower wolds it is also found occurring, but only in a limited extent. The average breadth of this latter district has been said to be 6 miles. The direction of the valleys is the same here as in the other parts of it, viz. east and west; but the ridges are seldom prolonged so as to become flat table-land, and therefore, according to Mr. Thorpe's theory, they have not afforded a resting-place for the deposition of diluvial sediment so much here as elsewhere.

In parts of the wolds extensive gravel-beds occur; they are chiefly found distributed along the line of the valleys of denudation. In two of the most remarkable of these valleys, viz. in that of the Dale Towns, and in Thixendale, the surface soil consists almost entirely of gravel, which is composed chiefly of chalk and flint. In the broad valley of the Dale Towns this gravel bed is in some parts nearly a mile broad, and being thinly spread forms very useful convertible soil, but in the narrow * Thixendale valley the accumulation amounts in some parts to 30 feet in thickness; and, being finely comminuted and covered with a very thin coat of soil, is rendered incapable of holding tillage: hence, unless copious and frequent dressings of manure are applied to crops on this soil, the cultivation of it is found to be unremunerating.

Under the general term Wolds is included a tract of land lying at the foot of these hills at their northern border, and extending from Speeton Cliffs to Malton, a distance of 20 miles by 2. It is in reality a portion of the Vale of Pickering, but, being of inconsiderable extent, has been classified with the Wolds; to which, however, it has no other affinity than being immediately contiguous; for the soil geologically belongs (as will be seen by the map) to the Kimmeridge clay. The surface, however, is so covered with diluvial matter, sand, peat, and gravel, that, except upon a very limited area, it is entirely irrespective of its geological formation.

Drift sands occupy that part which adjoins the hills, and peat covers the lower levels, which were heretofore frequently overflowed by the surplus waters of the river Derwent, but which now have been protected from these inundations by an embankment of that river, and a drainage of this district effected under the powers of an Act called 'The Muston and Yeddingham Drainage Act,' passed in the year 1800. At the north-eastern extremity of this tract, viz. from the edge of the Wolds at Hunmanby to the sea-coast of Filey Bay, a very tenacious diluvial clay is found forming the surface soil; and at the other extremity

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* By *Thixendale* must be understood the numerous ramifications of dales which begin at Aldrow, and terminate with their talus of débris at Eastburn Warren.

of it, near Settrington, the Kimmeridge clay is seen *in situ* underlying the chalk, and throwing out frequent springs, as is the case in other places along the northern and western escarpment of this range of hills.

*Holderness.*—Holderness has been generally designated, as its name implies, a low level tract. The name, however, implies somewhat more than this, and, in truth, an accurate survey of the district fully justifies its etymology; for this long projection of flat land is more hollow in the interior than at the line of coast. This the watershed proves, all the watercourses in Holderness falling westward and south-westward from the coast towards the river Hull. The annual encroachments which the sea makes upon the clay cliffs have been accurately ascertained and measured;* and several villages have within the period of history been washed away, such as Auburn, Hyde, Ravenspurn, &c.; so that, as the sea-barrier extended farther eastward, it was probably higher ground than it is at present; and perhaps, therefore, when our Saxon ancestors named it, the title of Hollow-der-ness was even more appropriate than it is now. The declination, however, from the east is inconsiderable, and thus in times when drainage was unknown, and the watercourses were permitted to flow as nature directed, an extensive swamp, called the Carrs, was formed at the union of these sluggish streams with the river Hull.

It appears that no attempt whatever was made to drain these Carrs until a comparatively recent period, but that they were permitted to remain a profitless morass, producing ague to the neighbourhood, and only affording shelter to the bittern and the heron. In the year 1761 an Act was passed, called 'The Beverley and Barmston Drainage Act,' by which powers were given for straightening the river Hull, and confining it within an artificial embankment; and also for making a subsidiary drain at a lower level, for the purpose of carrying off the flood-waters of Upper and Middle Holderness, and for discharging them into the river Hull near to its mouth by means of flood-gates. This tidal drainage, however, proved insufficient after very heavy rains, and the Carrs were inundated notwithstanding. Another outlet, therefore, has been subsequently made, and the waters have been conveyed by a cut of some magnitude into the river Humber, about three miles below the town of Hull.

The soils of Holderness are chiefly diluvial, and consist for the most part of clay, which clay corresponds, doubtless, with a detrital deposit described by Mr. Trimmer in a recent paper of

* Several admeasurements of different parts of the coast are given by Mr. Strickland. From these it appears that in some places the waste is as much as two yards of cliff a year. Upon the whole the encroachments average about one yard per annum.

the 'Journal of the Royal Agricultural Society of England,' and by him called till or boulder clay.

"It forms," as he states, vol. vii. p. 44, "a large geological district, in which the superficial deposits, from their extensive development, assume an important agricultural character. With some interruptions from the alluvial tracts of the Humber, the Wash, and the Yare, this district extends from the coast of Holderness, in Yorkshire, to the banks of the Thames, if not farther to the south."

This boulder clay is said to be the lowest member of the northern drift. It is largely interspersed with fragments of shells and rocks derived from older formations, and is of considerable thickness. It may be studied with advantage along the whole line of coast from Burlington to Spurn Point.

Occasionally, as at Barmston and Hatfield, a thin covering of drift sand is found reposing on the clay; and in one locality, viz. near Brandes Burton, there is a hill of gravel which, though not of much agricultural importance, forms rather a singular feature in this district. There are several isolated hills in Holderness; none however attain a higher elevation than 100 feet. The southern part of Holderness, bordering the River Humber from Hull to the Spurn Point, and comprising nearly 20,000 acres, is entirely alluvial, and the soil is of great fertility. That part of it which is still called Sunk Island, though no longer isolated, was first noticed and reclaimed from the tidal waters of the Humber in the time of Charles I. It appears that at first 1600 acres were embanked, and leased to certain individuals; and that at present it contains within its banks 4700 acres, having a chapel and several farmhouses erected upon it. There were persons recently living who could remember vessels sailing betwixt it and the mainland, to which it is now united by a bridge across a very narrow channel.

*Vale of York.*—The district thus designated, lying to the westward of the Wolds, is much of the same external character as Holderness. The Wold hills descend on the western side abruptly to their base; and throughout the greater part of the district the surface is varied only by a few drift beds of gravel and clay. Nearly the whole of this part of the Riding belongs geologically to the new red sandstone formation; this rock, however, lies so low hereabouts, and is covered by such a thickness of diluvial matter, that it may be for all practical purposes dismissed from consideration. The north-eastern portion of the district is crossed transversely by beds of the oolitic series; and here, consequently, considerable diversities of soil and surface present themselves. The lias clay extends in a band averaging about two miles in breadth from the river Derwent, near Howsham, to the Humber

at Brough. It furnishes extremely tenacious soils, which soils would perhaps be more profitably devoted to pasture than tillage.

The inferior oolite may be seen immediately underlying the chalk at the village of Acklam, where it occupies rather high ground. From thence it descends, but still forms a ridge of some elevation, and may be traced by Gally Gap to Howsham, and Weston and Firby. Passing along the range of the Wold hills in a southerly direction, no trace of the oolites can be found from Acklam until they re-appear near the village of Sancton; they then trend away in narrow beds lying parallel to the chalk, until they are lost and overlaid by the alluvia of the Humber banks. Wherever the beds of the lower oolite are near the surface a fine friable soil is found, well adapted for the growth of turnips and barley.

The upper oolite beds are also well defined. Beginning at the north-western edge of the Wolds, they are first met with about half way betwixt North Grimston and Wharram-le-Street. From this point these tabular hills range by Langton Wold to Welham and Malton. Like the inferior members of the series, the disintegration of this rock produces good turnip and barley soils; the same distinguishing characteristic of these soils, however, which has been pointed out by Sir John Johnstone in a paper of his in the first volume of the 'Journal of the Royal Agricultural Society of England,' is noticeable here also, viz. that the soil formed by them is equally well fitted for pasturage as for arable culture. At North Grimston this may be seen in some very superior grazing-land lying west of the village. Langton Wold also, though partly covered by aboriginal heather, is in other parts distinguished by the fineness of its herbage; and if we step beyond the limits of the Riding, and observe the grass-land in the neighbourhood of Castle Howard Park, we shall find ample testimony to the truth of this observation.

The remainder of the Vale of York district, and which constitutes three-fourths of the whole, extending south and south-westward from Garrowby Street, may be considered as practically level. It is crossed, as has been stated, in two or three places by beds of drift gravel and clay; these, however, are too unimportant in extent to merit any description.

The soils throughout this level tract, being for the most part diluvial, are various. Descending from the Wold hills near Pocklington, and passing over the narrow beds of lias clay which here form their base, we find a tract of chalky gravel extending from this town nearly to Market Weighton. Cultivation and the progress of agricultural knowledge have conduced to convert this, which was probably formerly a very hungry soil, into profitable arable land. Beyond these gravels, which do not extend far

from the parent hills, whence they have evidently derived their origin, we next arrive at a very barren tract of land, which forms rather a remarkable variety in the Vale of York. This belt, for so it may be termed, runs nearly parallel to the lias clay. It is about two miles broad, and extends almost continuously from within a mile or two of the Humber to the north-western confines of the Riding near Stamford Bridge. The surface soil is throughout a poor, blowing, ferruginous drift sand, chiefly covered with ling and furze, and distinguishable here and there by a few stunted Scotch fir plantations. Attempts at cultivation have been made from time to time in various parts of this unpromising tract, but all such attempts have been abandoned almost as soon as made, until of late years. Recently, however, it has been discovered that beneath this barren surface there lie beds of clay and marl; and that, wherever these beds approach near to the surface, great benefit may be derived from the practice of digging out the clay and spreading it largely over the land. In some cases from 100 to 150 cubic yards per acre have been thus spread; and in no case has it been found advisable to apply less than 80 yards per acre. In this way, upon an estate belonging to Mr. Denison, near Pocklington, between 200 and 300 acres have been reclaimed, and converted from a mere rabbit-warren into very good farming land; and which may be now worth nearly twenty shillings per acre.

Mr. Maxwell, of Everingham Park, has also pursued this system for some years, with equal judgment, and not less advantage. It has also been tried pretty extensively upon the property of George Hudson, Esq., M.P., near Market Weighton. Indeed, it is probable that the whole of the tract now described, containing not less than 15,000 acres, more than half of which is entirely uncultivated, and the rest extremely infertile (with the exceptions above named), is equally capable of reclamation. This subject will, however, be alluded to hereafter.

Having thus endeavoured to give an outline of the geographical features of this riding, and to describe the character of its soils and surfaces, it becomes necessary to proceed to notice the peculiarities of its agricultural management.

In order to show the more strikingly the progress which agriculture has made in parts of this Riding in late years, it will perhaps be permissible to revert to a period somewhat anterior to the date of Mr. Strickland's survey, and to refer to the notice taken of it by agricultural writers of the last century.

Arthur Young, in his 'Northern Tour,' published in 1770, says, respecting the Wold district (vol. ii. p. 7),—

"Between Driffield and Burlington the country is various, but chiefly open wolds; in them the soil is indifferent, and lets from 2*s*. to 7*s*. 6*d*.

per acre, but in the enclosures it is much dearer. . . . Across the wolds I could not but regret the wretched management which left such large tracts of land in so uncultivated a state. It lets from 4*d.* to 4*s.* an acre between Boynton and Hunmanby. They plough up the turf and sow barley, or more often oats, and then leave the soil to gain of itself a new sward; this is their management every six years. Whereas, all the country would admit the Norfolk course of husbandry, of 1, turnip; 2, barley; 3, clover, and ray-grass *for five years;* 4, wheat: by means of which the soil would always be clean and in heart, the food for cattle would be greatly increased, and the farmers better able to pay 14*s.* per acre than they now are 4*s.* Farms rise from 30*l.* to 100*l.* a-year; they join their flocks in folding, but have no turnips to feed them with in winter and spring. I forbear to speak in my own person of the husbandry in the neighbourhood of Ganton, the seat of Sir Digby Legard, Bart., as he has, with the utmost politeness and patriotic spirit, given me a most particular and judicious account of the rural economy of that country, with many admirable hints for improvement. I proceed at once to insert it:—

"'Sir,—As I apprehend that it will be more agreeable to the plan of your northern tour to give you a general account of the state of husbandry in my neighbourhood, than the particular history of those experiments which I have made, chiefly with a view to determine some points which seemed doubtful, or to ascertain the most beneficial effects of cultivation, I shall confine myself in this letter to general ideas of improvement which are peculiarly applicable to a heathy and mountainous country, such as prevails in many parts of this kingdom. The principal of these are the wolds in the East Riding of Yorkshire, Lincoln and Newmarket heaths, and Marlborough downs. These and some other parts of a similar nature are, I presume, the most considerable tracts of unimproved country in England; and as I imagine the whole to be at present extremely low-rented, thinly inhabited, and capable of great improvement, it becomes a national object, as well as of the utmost importance to the proprietors, to examine in what manner this immense extent of waste land may be enabled to yield a greater produce both of fodder and grain, maintain a greater number of inhabitants, and thus strengthen the community whilst it enriches the individuals. My situation on the edge of the wolds, my long and constant residence in this country, and my attention to every object of improvement, have, in some degree, enabled me to give hints on this subject; and the advantage of above 5000 acres of unenclosed wold land not far from my house has afforded me a spacious field of improvement. The estate where I have resided several years consists of upwards of 6000 acres, and contains three villages, at about a mile distant from each other and nearly in the centre of the estate. The unenclosed parts of this estate, or what is called wolds, of 5000 acres, have never been let for more than 1*s.* per acre; and what I say of a particular parish is applicable to a very extensive country 20 miles long by 15 broad. . . . The general use made of the open wolds land is to stock with sheep, and cultivate a small part of it with the plough. But this tillage lying at a great distance from the farmhouses, which are all (in the parish I

speak of) situated at the foot of the hills, it is impracticable for the farmer to get his dung conveyed thither at any moderate expense. He never attempts it: all the manure this land gets is from the sheep-fold, and were he content to plough no more than he can thus well improve by twice folding, it would be well; but the rage is so great, that he every year has been accustomed to plough up a fresh part of his sheep-walk, to take a crop or two, and then let it lie fifteen or twenty years, till the natural grass has again formed a kind of turf; but it will sometimes be forty years before the land is completely sodded over. This ruinous practice is too common, and where it has long prevailed the farmer has seldom a threefold increase. He sows 4 bushels of oats and 3 of barley, and is happy if he can reap 12 bushels of the former and 5 of the latter. He may plough half an acre a day with 2 horses: therefore, his crop being worth 18*s*., if we deduct 12*s*. for seed, tillage, and rent, his profit is 6*s*.; but the value of the straw is not equivalent to the expense of mowing, binding, and leading home; 2*s*. ought to be charged for these articles, and thus is his profit reduced 4*s*. per acre. Our farmers stock nearly in this proportion, viz. a sheep for every acre: a flock of 500 sheep requires a sheep-walk of 500 acres, besides a winter supply of fodder. These sheep are small, and when fat weigh 12 or 14 lbs. per quarter; the fleeces weigh 3 lb. at a medium, which is scarce worth 2*s*. In this light soil they seldom use more than two horses to a plough, and never more than one man and a boy; indeed I think a driver with two horses quite unnecessary. . . . . I do not doubt but I shall be able to demonstrate that the same individual land may, in a few years, and at no very great expense, maintain five times its number of inhabitants, six times its quantity of corn, support twice the number of cattle, and let for eight times the present rent.' "

He then details with great minuteness the method by which he proposes to accomplish these improvements, and which are chiefly interesting as being the earliest attempts at improving these uncultivated wilds of which we have any record; these are—enclosure, the help of the sheep-fold, and a proper choice of grasses. He further says,—

" 'I have enclosed 300 acres on the top of the wolds, and have laid down the greatest part with various kinds of grasses. The 300 acres were as bad as any in the lordship, and the same improvement may equally extend to 5000 acres; but as so large a supply of grass and hay serves only for the support of cattle, and as a country should be peopled as well as stocked, I shall make a calculation of what corn this land may produce, what number of inhabitants it may support, and what herds and flocks it may maintain. For this purpose farmhouses must be built, and a proper quantity of tillage, meadow, and pasture allotted to each farm.' "

Such is the relation, given nearly 80 years ago, of the state of wold husbandry by one of its earliest improvers, and such are the modes by which he proposes to increase its productiveness. It will be seen that the exigencies of an increasing population, and

the aids which science has at length imparted to agriculture, have caused his sanguine expectations to be more than realized. It can be proved that in the very district to which Sir Digby Legard refers, the produce of wheat has been doubled, that of oats has been increased five-fold, of barley six-fold; and that wherever skill and capital have been applied to these uncultivated hills, rent has been advanced even as much as twenty-fold.*

The notice taken by Arthur Young of the agriculture of other parts of the Riding is not so copious, and therefore a brief extract may suffice:—

"I remarked the whole way from York to Beverley that they used many oxen in their husbandry works; all the waggons I met had two oxen and two horses in them. At Barmley Moor the adjoining moors are common to the houses around them; would let, if enclosed, at 3*s.* 6*d.* or 4*s.* an acre, without further improvement, and might be made, with nothing but good husbandry, worth 10*s.* an acre. The soil in this country is chiefly sand and gravel; their course of crops

"1. Fallow.
2. Wheat.
3. Barley.

"Between Market Weighton and Beverley I observed several warrens, which must raise the wonder of every traveller to see such good land left to so woeful a use; the turf is exceedingly rich and fine, and the plentiful crops of thistles scattered about it prove the natural goodness of the soil; the thistle is so luxuriant and exhausting a vegetable, with so strong and penetrating a tap-root, that it is scarce ever found on bad soils."

The progress of improvement, however, so much desired by Mr. Young and his correspondent, was tardy. The principles were recognised, but as yet there was no general adoption of them. Capital was not abundant; and we must remember that prices were not, at that time, stimulative of agricultural enterprise: for we find, a few years later, viz. in the year 1788, in Marshall's 'Rural Economy of Yorkshire' (to which we have before alluded), a very accurate and elaborate account of the husbandry then practised in the eastern parts of the county,

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* The extent of surface occupied by the chalk formation is about 249,000 acres. The property-tax returns of 1846 show that the rental of this acreage is at present 255,378*l.*, being an average of somewhat under 20*s.* 6*d.* per acre. The rent, however, varies much in the different divisions, *e. g.*:—

| | Average Rent per Acre. |
|---|---|
| On the wold part of Bainton Beacon division . . | £1 1 0 |
| " " Buckrose . . . . . | 0 17 0 |
| " " Dickering . . . . . | 1 0 0 |
| " " North and South Hunsley . . | 1 8 0 |
| " " Holme Beacon . . . . | 1 6 0 |
| " " Bishop Wilton Beacon . . . | 0 16 6 |

especially of the Wolds, and that he laments that so much land of a promising nature should have been suffered so long to remain either as a sheep-walk or rabbit-warren.

"Formerly," he says (vol. ii. p. 246), "the wolds, whether parcelled out in common field, or disposed in more entire properties, lay entirely open, excepting a few yards about the villages. The East Wold vale still lies in a state of common-field ; but on the higher wolds some spirited attempts have lately been made at enclosure.

"Sir Christopher Sykes may, I believe, claim the honour of being the first successful planter on the wolds ; attempts had formerly been made, but without success : owing, perhaps, more to the smallness and thinness of the plantation than to any other mismanagement.

"Sir Christopher Sykes, I am informed, is now contracting with a nurseryman for upwards of 500 acres of planting, to be finished in ten years ; an undertaking which does him infinite credit.

"Should the time arrive when the higher swells shall be crowned with wood, and the intervening valleys be intersected with living fences, forming enclosures of 8 or 10 acres, the climature of the wolds will be rendered some degrees more genial than it is at present, and the productiveness of the soil double that which it has hitherto been."

From this period may be dated the commencement of a better system of Wold husbandry. To Sir Christopher Sykes may be conceded the merit of having been, not only as Marshall claims for him, the first planter, but also the most extensive reclaimer of these wilds; for his plantations being continued from year to year, till they amounted to nearly 2000 acres, not only afforded shelter to the cattle, and better climate to the corn, but also furnished materials for fencing; and thus, in process of time, a subdivision of the unenclosed fields took place, and a better, though as yet imperfect, system of culture was introduced, which put an end to the barbarous open-field management.

The stimulus also given to agriculture by the war-prices soon after this period was not without its influence on this part of the country, and caused a great portion of the sheep-walks to be converted from grass into arable land. The mode of conversion was, however, as rude as possible ; still rents were doubled, and the process went on ; yet, this process being one of exhaustion, it seemed as if, within a certain cycle of years, the Wolds were about to return to more than their original state of barrenness.

With respect to rent Marshall says—

"Upon the large farms, 6*s*. to 12*s*. per acre, the rent depends chiefly on whether the tenant has or has not liberty to *break up old sheep-walk*, with which the large farms mostly abound. No wonder landed gentlemen are so tenacious of their old grass-lands ; they are treasuries, whose keys they would be blamable in delivering up without a suitable consideration."

Of turnips he says—

"The turnip crop may be said to be a new thing to the wolds, not of more than twenty years' standing, though singularly adapted to the soil, and notwithstanding it has in Norfolk been an established object of culture more than a century. At present this crop is in full estimation, being considered as the most solid basis of wold husbandry."

About twenty-four years after Mr. Marshall's treatise, Mr. Strickland's 'Survey' was published. In this work all the economies and practices of husbandry are treated of with the greatest care and minuteness. It would be quite impossible within the limits of this Report, nor would it be consistent with its object, to follow Mr. Strickland through all the branches of his subject; it will be sufficient if we extract a few such passages as show the modes of cultivation which then prevailed in the district.

It must be borne in mind that at the time of this 'Survey' war-prices had reached their acme. Wheat for the year 1812 averaged 122*s.* per quarter; barley, 66*s.*; oats, 44*s.*; beans, 72*s.*; and beef and mutton had reached 8½*d.* per lb. During the twenty-four preceding years these and other causes had operated as most powerful incentives to that agricultural enterprise of which Mr. Marshall had seen the dawn. We should have been prepared then to find that the cultivation of the soil had proceeded *pari passu*: whether this was the case let Mr. Strickland's pages tell. War-prices had done their utmost; but what Liebig denominates the day of rational culture had not yet arrived.

On the subject of arable land Mr. Strickland says, p. 105—

"On the wolds, and country peculiarly adapted to sheep, but from various circumstances unfavourable to corn, particularly wheat, a stranger would be surprised to see at this time at least two-thirds of the land under the plough. This district, till of late years, had continued for ages in the open-field state; and a few townships still remain so. They were usually divided pretty equally into a tillage field, a common pasture, a sheep-walk (which never came under the plough), and an out-field, from which a crop of oats was taken every third, fourth, or fifth year, and which was left without either manure or grass-seeds, to be depastured with sheep till it came again into the course to be ploughed up. . . . . About two-thirds of the country was given up to pasturage and one-third to grain, producing at the same time winter provision for their stock. Unfortunately those beautiful sheep-walks and pastures, which the eatage of so many ages had rendered verdant and fertile beyond any to be met with on the other downs or heaths of the kingdom, held out an irresistible temptation to modern avarice, and under the plea of improvement they have been ploughed out.

"The average proportion of the tillage land on the wolds at present may be taken at full two-thirds.

"In Holderness something more than one-third is under the plough; towards the south-eastern extremity considerably more, probably amounting to one-half.

"In most of the open-field townships on the wolds two crops and a bare fallow have been from time immemorial the constant course; the tillage field was divided into 6, 9, or 12 falls or fields, so that there might be at least one of the divisions under each kind of grain, and fallow every year. The course pursued was generally as follows:—

| | |
|---|---|
| "1. Fallow. | 4. Fallow. |
| 2. Wheat. | 5. Barley. |
| 3. Oats. | 6. Peas or beans. |

"After enclosures had taken place upon the wolds, or upon the new letting of farms, various rotations were adopted; but the general system is to preclude the tenant from sowing two crops of white corn in succession. The following is as frequent, and probably as good, as most in use:—

| | |
|---|---|
| "1. Turnips. | 5. Turnips. |
| 2. Barley. | 6. Barley. |
| 3. Red clover or tares. | 7. Grass. |
| 4. Wheat. | 8. Grass. |

"In Holderness, on the clay and strong loamy lands, two crops and a bare fallow form the usual course; wheat on the fallow, and beans (sometimes oats) after the wheat; but on the fine gravelly and loamy turnip soil, extending through the middle of Holderness, by Catfoss, Rise, Skirlaugh, Coniston, and Bilton, the course is generally,

| | |
|---|---|
| "1. Turnips. | 4. Wheat. |
| 2. Barley. | 5. Beans or peas. |
| 3. Clover. | |

"In Howdenshire, along the course of the Ouse, is a tract of exceedingly rich warp land: it extends about 2 miles in breadth, and is usually cultivated with wheat, oats, beans, potatoes, and fallow, but flax and rape-seed occasionally intervene."

Mr. Strickland then treats in detail of the crops commonly cultivated, of which we must notice the principal, with a view to show the produce at that time usually obtained.

"*Wheat.*—From 2½ to 3 bushels per acre are sown broadcast, and about 1½ bushel when drilled. Produce from 12 to 24 bushels per acre on the wolds; but on the good wheat-land in the other parts of the Riding, from 20 to 40 bushels per acre.

"*Barley.*—Quantity of seed from 2 to 2½ bushels per acre. Produce from 3 to 5 quarters per acre; after a good crop of turnips, however, a greater quantity is occasionally obtained.

"*Oats.*—Quantity of seed from 4 to 5 bushels of potato-oats per acre; of the Friezeland and Tartarian, about 6; and of the Poland, 8 bushels per acre. But it is a general rule that the richer the land the more seed should be sown upon it, or the produce will be strong straw with very little grain. Produce on the warp land of Sunk Island, about 8 quarters per acre; in the rest of Holderness, in Howdenshire, and in the lowland parts of the Riding, about 6 quarters; and on the wolds (excepting on land that has recently been sheep-walk), less than 4 quarters.

"*Beans.*—4 bushels per acre are sown broadcast. Produce in Holderness, 4 quarters; on the wolds (where, however, they are seldom cultivated) it does not exceed 2 quarters."

Having thus endeavoured to trace out the successive steps which have been noticed in the culture of this Riding by the foregoing authorities, its present condition and the peculiarities of its agriculture must be proceeded with.

First, of the *Vale of York.*—Less improvement is noticeable in the agriculture of this than of the other two divisions of the Riding, owing chiefly to two causes, viz. the inferiority of its soils, and also the difficulties and inefficiency of its drainage.

With the exception of the warp soil lying adjacent to the river Ouse in Howdenshire, referred to by Mr. Strickland, and some limited oolite and gravel beds, the prevailing soils throughout this level are tenacious clay and blowing sand.

Upon the Howdenshire warp soils (*e. g.* at Saltmarsh, Sandhall, &c.) there is some extremely good farming. Upon this land for a considerable number of years the potato has been largely and profitably cultivated. In fact, upon the culture of this root the success of the course of cropping mainly depends, and therefore the partial destruction of it within the last two years has caused a most serious loss to the great potato-growers of the district. Their mode of cropping is thus: 1, potatoes; 2, wheat; 3, clover or beans; 4, oats or barley. The preparation of the land for potatoes here is equivalent to a turnip fallow elsewhere, and a similar process is followed. The land is set out in ridges 30 inches apart; and a heavy application of fold-yard manure is necessary to insure a crop. The time for taking up immediately succeeds the housing of the corn, and to the people of this district has all the importance of a second harvest. In a good potato year the produce per acre amounts to 400 bushels.

Mr. Strickland remarks that, in Howdenshire and on the eastern bank of the Derwent, flax was grown in considerable quantities: it is still partially cultivated, but not so much so as at the time when Mr. Strickland's book was published. The statements on this subject made by Mr. Wells of Booth Ferry, and other extensive flax-growers, seem to intimate that the profit derived from its culture will hardly, on these soils at least, compensate for the exhausting properties of the plant.

To the remainder of the tract of country now under consideration it is hardly possible to assign anything like a definite system of agriculture: it may, however, be said that, where clay prevails, the old three-fold course, viz. fallow, wheat, beans, is the adopted practice; with such infringements of it as the farmer thinks he can with safety or profit introduce: for instance, oats are now and

then substituted for beans; and occasionally, though more rarely, the three-fold course is protracted into a four-fold, by sowing a mixture of clover and rye-grass in the wheat crop in spring: this last is in effect a modification of the Essex system; and it is desirable that it should be more extended. But there are serious obstacles in the way of such better farming; such as, small enclosures, fences of undue proportions largely interspersed with hedge-row timber, and lastly, want of drainage; all these conspire to render a fallow once in three years absolutely indispensable, in order to keep down the weeds and to preserve the land in anything like heart. The farms of this district are not large, few of them exceeding 200 acres; they more generally average 150 acres. The tract has been said to be generally level. From the foot of the Wolds, the rivers Derwent and Foulney, and other smaller streams, which traverse it and constitute its drainage, run in a south-westerly direction. The fall of these waters is very gradual, and the course of some of them extremely tortuous, so that after heavy rains the lowest levels are completely inundated; and from want of a proper outfall the ditches during a great part of the winter are frequently quite full.

It cannot be denied that, of late years, under-draining has been carried on in this part of the Riding with laudable activity. Many proprietors have established tile-kilns on their estates, and have either done the whole work for their tenants (charging them a percentage), or have furnished them with tiles; yet still the impediments above alluded to serve to confine these efforts to certain localities more favoured than others.

Upon the sandy and gravelly beds which occur in the Vale of York, the four-shift husbandry, viz. turnips, barley, seeds, wheat, is practised. The sandy zone, previously described, would seem, from the nature of its surface, to be not ill adapted for the growth of turnips, potatoes, &c., but the first step in the process here, as elsewhere, must be drainage. In the instances previously pointed out where this has been effectually done, the results are very favourable to similar attempts being made in other parts of it. Mr. Denison, in a paper which he published in the 'Transactions of the Yorkshire Agricultural Society,' has shown the benefits which his estate has derived from draining, marling, and subsoiling. He calculates the expense of subsoiling at not more than 26*s.* per acre, and states that by these means land, which had two years previously been let for not more than 2*s.* 6*d.* per acre, was made to produce 10 quarters of oats per acre. All these improvements, however—viz. marling, which cannot be effectually done for less than 3*l.* per acre, under-draining at about the same amount, and subsoiling, costing as has been said about 26*s.* per acre—involve an outlay which it would neither be practicable, nor if practicable

prudent, for a tenant of this part of the country to incur, where leases are almost unknown, and no security is afforded for heavy investments of this description.

*Of Holderness.*—The soils of Holderness are so various, that all attempts to generalize the management pursued in this division of the Riding would be in vain. It has been stated that they are diluvial. The surface, however, is more clayey than otherwise, and the area occupied by the gravels and sands is very limited. The Carrs, of which the surface is peat, extend from Brigham to Tickton, and comprise nearly 17,000 acres. On these peaty soils, as well as on the sands and gravels, turnips are cultivated, and may be eaten by sheep, and this consequently involves the four-shift course. No soil is better adapted for the growth of rape than the peaty Carrs; prodigious crops of it are here produced; and it rarely fails unless the season be extremely dry.

The general drainage of Holderness, effected under Acts of Parliament already mentioned, has afforded such an outfall for its surplus waters, that generally there is little difficulty in carrying out in any part of it a thorough system of under-draining. In many parts of it this has been done vigorously within the last two or three years—so much so, that turnip-culture has been introduced on some farms where previously the land produced nothing but a miserable stunted herbage, or was devoted to the old, profitless, monotonous wheat, beans, fallow course, and hardly repaid the expense of cultivation.

The advantages which follow from under-draining and a judicious course of cropping cannot be more strikingly demonstrated than upon a farm in the parish of Frodingham, N. Holderness, belonging to and occupied by P. Saltmarshe, Esq., of Saltmarsh, near Howden. His agent, Mr. Smith, has obligingly furnished some details concerning it. He says—

"The management formerly adopted at Frodingham Grange was the four-course system; but, owing to the land being what is termed clover-sick, we have altered it as under, viz.:—1, fallow for turnips; 2, wheat, oats, or barley (one-half of this sown with clover-seeds); 3, one-half seeds, one-half rape; 4, wheat; 5, beans, peas, or tares. We are all in the same dilemma as regards seeds: there is a general complaint about their failing. I hear of many persons pursuing the five-course (that of sowing what we call black ware), which I have not the least doubt will invigorate the plant. This farm is now all drained; we began with thorns, but soon came to the conclusion that tiles would be more advantageous in the long run. Where thorns were used the results were good for a few years; but the fields are now done with tiles about 18 inches deep. It is the fashion now to drain 4 feet deep, but our draining is so far satisfactory."

Without venturing upon the controverted question of shallow

*versus* deep draining, or hazarding an opinion whether the 18-inch tile-drain may not in the long run follow the fate of the previously tried thorn-drain, it may be asserted that there are in other parts of Holderness thousands of acres condemned, as this farm was twenty years ago, as being poor, bad land, which are equally susceptible of improvement, and which would, if equally treated, produce the like results.

The following communication from a practical farmer residing in South Holderness furnishes an accurate and intelligible report of the farming pursued in that district:—

"*Keyingham Marsh, Dec.* 10, 1847.

"The district of South Holderness varies considerably in its soil, and consequently the cultivation will vary much. There is a large quantity of land between Hull and Patrington, protected by embankments, and entirely composed of soil deposited by the waters of the Humber—not less than from 20,000 to 30,000 acres. My farm is upon this part, the only variation in which appears to be in the mechanical division of the soil, caused by the various currents in the Humber when the waters have been depositing the warp, where the coarser particles of soil are left, composed of silicious and calcareous sand, with broken shells: there the soil is freer, and very much superior for cultivation, but for grazing some of the other parts are quite as good. The rest of South Holderness is undulating, mostly good land, composed of gravel-hills and a reddish-brown clay soil, mixed with rounded stones and pieces of white marl or soft chalk. Nearly the whole of this land is under the plough—at least eight-tenths—while the warp-land, within the last few years, was nearly half of it in grass; but the losses caused by the introduction of those epidemic diseases amongst cattle and sheep, by the importation of foreign stock, has been so great, that a large quantity of this grass is getting ploughed up every year. The size of the farms varies upon the warp-land—from 200 to 800 acres; but upon the higher land there are a large number less than 200 acres. In the cultivation of my farm I have endeavoured to keep three objects in view, viz. to cross my crops as much as possible, to avoid dead fallows as long as I could keep my land clean without them, and never to sow a crop when the land was out of condition. Upon the freest, and what I consider my best land, I have usually fallowed, with a plentiful dressing of manure, for rape, to stand for a crop, which is generally off the ground by the beginning of July. I immediately plough the land up and work it well with the drag, and, if it requires it, give a second ploughing for wheat: this is almost always my best wheat crop. The next year I sow beans, about 15 inches apart, in the drills, horse-hoe twice, and hand-weed twice; indeed as long as we can get amongst them without doing harm. I give the bean-stubble a light dusting of newly-slaked lime, while the dew is on, to kill the grey slug; then plough for wheat; then afterwards fallow again. On another portion of my farm I fallow for wheat, without any manure, as I commonly get far too much straw; then clover-seeds, to pasture or mow; then wheat. I manure the

wheat-stubble well for oats; then beans and fallow. The next time I take wheat, oats, beans, wheat, beans. I have sometimes taken, after fallow, wheat, beans, wheat, beans; but the bean-crop is so extremely hazardous I do not find this a profitable course. For several years lately beans upon the warp soil have died, while they were in full leaf, before the grain was fully ripe, without any external apparent cause. I have tile-drained the greatest part of my farm, and find it to answer well; the land will evidently bear greater extremes of both wet and dry without injury.

"The cultivation of the higher land in South Holderness, wherever it is gravelly or light enough to grow turnips, the four or five course system is invariably adopted, but by far the greater part is quite too strong for turnips; the usual course upon this land is to dead fallow for wheat, with a dressing of fold-yard manure or lime—say from three to five chaldrons to the acre—then seeds, wheat, oats, beans, where the land is good; but on the inferior land the oat-crop is not taken. I believe this is the course generally followed and approved of; but the soil often varies so suddenly that one small field will have three or four different qualities of soil in it, and, although all tolerably good, it makes the land very difficult to crop to the best advantage. Tile-draining upon this land, when carefully done, and where the drains are laid from $2\frac{1}{2}$ to 3 feet deep, is doing more towards increasing the produce than anything that has ever been introduced. Although within the last twenty years there has been no more grass-land in this part to break up, yet the produce has very much increased, principally by deeper ploughing and better draining. I have no hesitation in saying the land, where properly cultivated, is improving every year. I cannot help feeling surprised at the prejudice a great number of landed proprietors in some districts have to the breaking up even of inferior grass-land, from the fear of having their estates deteriorated. Let them secure and encourage a good tenant, and their estates will improve instead of getting worse, while the wealth produced to the country from an acre of well-cultivated land is at least four times greater than from the same land under inferior grass.

"MANSFIELD HARRISON."

These alluvial soils are confined to South Holderness. Mr. Harrison's description of the cultivation of the other soils, viz. the gravels and reddish clays intermixed with rubble-stones, may be considered as applying also to North and Middle Holderness.

*Of the Wolds.*—As we shall endeavour to make it appear that, within the last thirty-five years, much greater progress has been made in the agriculture of this district than of those two which have been described, we shall perhaps be justified in devoting more space to the details of its farming than we have thought necessary with respect to the other two.

Various causes might be assigned for this, upon which it is not necessary to dwell at present, such as the amelioration of the climate by enclosing and planting, the discovery and use of light and portable manures, &c. There is one circumstance, however,

connected with the farming of this district, which should not be passed over without notice.

It is a commonly received opinion that an outlay of capital upon the soil requisite to maintain it in a state of progressive improvement cannot be obtained without the security of a lease. Now whatever may be the force of this observation with reference to other parts of the kingdom, it is wholly inapplicable to the Yorkshire Wolds. There may be an isolated case of the existence of a lease, but the universal custom of the district is yearly tenancy, terminable at six months' notice, with such covenants as the landlord and tenant may mutually determine to be the best suited to their particular cases. That under a different system better farming would have prevailed, is a speculation which it is needless to entertain. It is sufficient to state that the present race of Wold farmers are not wanting in enterprise and independence, and that there seems to be no general wish for an alteration in the condition of their holdings. Of the mode of their managing their farms it remains then that we attempt a representation.

The surface-soil of this, as of all other parts of the chalk formation throughout the kingdom, is such that the four-fold or alternate course of cropping has been established, as best suited to it, viz.—

1. Turnips.
2. Barley.
3. Clover-seeds.
4. Wheat.

This course may be said now to prevail universally, modified, doubtless, as will be seen, by circumstances and contingencies; and the steady pursuance of this system has at length led to the abandonment of the opinion which formerly obtained, that the Wolds was a country only adapted for sheep; that its soil was unproductive; and that the expense of its cultivation was great, as compared with its scanty returns.

It is not surprising that, when Mr. Strickland wrote his 'Survey,' this should have been not only his opinion, but that various other intelligent persons, whom he quotes, should have coincided with him in lamenting the havoc which the plough had been suffered to commit in the beautiful and verdant sheep-walks and pastures. It is only necessary to reflect for a moment, that not only the old outfield course (viz. oats every third, fourth, or fifth year, and then natural grasses), and also the tillage course (viz. three crops of corn and a bare fallow), was essentially an exhausting system; but also, that after the enclosures had taken place, and our present Norfolk rotation been introduced, it was utterly impossible to carry it on for want of some fertilizer, such

as bone manure, &c., at once portable and procurable at such a cost and in such quantities as to bring its use within the sphere of the usual husbandry operations.

"The land," says John Tuke, one of Mr. Strickland's correspondents, "becomes completely exhausted; the quantity of straw does not afford a sufficient return for the turnip-crop: that consequently fails; of course the succeeding crop of corn and the seed-grass fail also. Little stock is therefore kept, and the land, instead of being improved, becomes of less value than when in open sheep-walk."

Acknowledging, therefore, as farmers did, the truth of observations such as these, they tried the practice of letting their clover-seeds stand for two years, thus to impart more freshness to the land. Not only, however, was it found that the turnip-crop was liable to fail for lack of proper manure, but also another very unexpected difficulty arose, which threatened the total interruption of this mode of husbandry, and this was the impossibility, as it began to appear, of growing clover once every four years, and that therefore the thus protracting the four-course shift into five-course was only an aggravation of their difficulties. It was not without propriety, then, that Mr. Strickland and others joined in recommending Wold farmers to rely chiefly on the breeding of sheep, and that corn should be grown only as subservient to that more important object.

It appears (*Strickland*, p. 211) that bones had been used by a few persons in the East Riding; they had been applied to the land at the rate of from 60 to 70 bushels per acre, at the expense of 2*s.* per bushel. The mode of using them seems to have been to break them, probably by the hammer, into small pieces, to cover the heap thus broken with earth six inches thick, and then spread them on the land made ready for turnips. From this dressing the first crop was said seldom to have derived much benefit, but its fertilizing properties were very conspicuous in the succeeding crops—hence it was recommended to give a slight dressing of manure with the bones, to insure a first crop. Such were the auspices under which this material was first introduced.

Within the last four or five years guano has been tried on these soils, instead of bones, for the turnip-crop, and about 2 or 2½ cwt. per acre have been used. In the showery summer of 1845 this fertilizer seemed to answer well, and exceedingly good crops of turnips were obtained from it. A dry season, however, such as that of 1847, renders its use on these soils at least precarious, and it will therefore probably never supersede bones.

Although the use of these comparatively cheap and portable manures has removed much of the danger of failure to which formerly the turnip-crop was liable, yet it was inadequate to

remedy the defect which then threatened and still threatens the integrity of the four-course system, viz. the liability of clover-seeds to fail if sown so frequently as once in four years.

To whatever cause this phenomenon may be attributed,—whether it arises from an exhaustion of the mineral constituents of the soil by the plant itself; whether from excretion by its roots, as French chemists have said; or whether, as contended for by Mr. Thorp, it is always killed by frost, and this in proportion to the want of cohesiveness of the soil, occasioned by the too frequent growth of it;—whether these or any mysterious laws of vegetable life be the causes of its failure, the remedies that have been hitherto applied have proved insufficient.

With respect to the exhaustion of the food of the plant, Professor Liebig has asserted—and his assertion is confirmed by the experience of practical men—that, "where the intervals at which the same plants can be cultivated with advantage are very long, the time cannot be shortened even by the use of most powerful manures." The excrementitious theory, we believe, has been given up. Indeed, even if this theory had been ever fairly established, yet its supporters do not appear to have ever suggested a counter-agent.

Then as to the remaining reason assigned by Mr. Thorp for the failure of the clovers, viz. that they are killed by frost, it can only be affirmed that the best Wold farmers—men upon whose judgment and accuracy the greatest reliance can be placed—have followed Mr. Thorp's advice most implicitly; have endeavoured to obtain compactness of the soil in the way he recommends; have *pressed* their land when sowing it with wheat; have rolled it with Crosskill's clod-crusher immediately after sowing, and again in March; have rolled the clover-seeds in autumn with a smooth iron roller, have covered them with a good dressing of fold-yard manure, and have avoided autumnal eatage; and yet, after all these precautions, they have found that the plant, though looking pretty well during autumn and even winter, has dwindled very much away ere the month of April arrives; and thus they have been compelled to relinquish the quadrennial growth of it, and to endeavour to find a substitute. All substitutes, however, hitherto tried have proved of inferior value. Of these, tares have occasionally been adopted on the Wolds as a sheep pasture. Compared with clover, however, they afford a scanty herbage. In wet weather the trampling of sheep is injurious to them; but the chief evil is that on these soils they are found to be prejudicial to the succeeding corn-crop. Rape has been substituted for clover on the *deep Wolds:* and it was noticed by Mr. Strickland that a better crop of wheat was produced here after rape than by any other course. But in the spring and early summer, when sheep-meat

is most in request, rape is found wanting; and upon the shallow Wold soils it is in vain to attempt the growth of it. A crop of peas has in some instances been taken as a substitute; the same objection, however, applies to peas as to tares on the Wolds, that the following corn-crop is inferior both in quantity and quality. Perhaps the best practice, where it has been found necessary to *rest* land from clover, is to take a turnip-crop after the oats or barley. Supposing, therefore, that a Wold farm consisted of 200 acres of arable land, the course to be pursued would be this:—

| | | | |
|---|---|---|---|
| 1st Course | Field No. 1, | 50 acres, | Wheat. |
| | ,, No. 2, | 50 ,, | Turnips, hybrids, and swedes. |
| | ,, No. 3, | 50 ,, | Barley or oats. |
| | ,, No. 4, | 50 | *a* 25 acres, Clover-seeds. |
| | | | *b* 25 acres, Turnips, white. |
| 2nd Course | Field No. 1, | 50 acres, | Wheat. |
| | ,, No. 2, | 50 ,, | Hybrids and swedes. |
| | ,, No. 3, | 50 ,, | Barley or oats. |
| | ,, No. 4, | 50 | *b* 25 acres, Clover-seeds. |
| | | | *a* 25 acres, White Turnips. |

So that, as the four-fold course goes round, by inverting the half-shift *a* and *b* in field No. 4, the land has only to sustain clover once in eight years.

It may be objected that this is in effect a violation of the very principle contended for—that if this course were pursued year after year, the soil would become *turnip-sick*, just as, according to common parlance, it has become *clover-sick*. It must be borne in mind, however, that this shift—or, as it may with more propriety be termed, make-shift—is only applicable to the thin Wold soils. Upon the deeper parts other means, such as we have already pointed out, may be provided; upon the thin soils, however, this system has been tried for some years in many cases, and with good effect. Chemical reasons might be adduced to show that of all vegetable products turnips are the most readily supplied with the food that is needed for their growth. This has been shown by Mr. Huxtable and others; and in this view practice seems to coincide.

To the *turnip cultivation* of this district more than to any other cause may be attributed its increased products and the gradual amelioration of its soils. Mr. Thorp states * that within twenty-five years the quantity of wheat grown in this district had been doubled, and of barley quadrupled; and in proof of this he quotes the returns made by the Driffield Navigation Company of the

* Page 105, Yorkshire Agricultural Society's Transactions, anno 1841.

freightage of corn conveyed along their canal; which canal, until very recently, was the only outlet for the exportation of the surplus produce of a very extensive agricultural circle, of which the market-town of Driffield is the centre. The returns are as follows:—

| | | | | Qrs. | Sacks of Flour. |
|---|---|---|---|---|---|
| In | 1819, Wheat exported to Hull, Wakefield, &c. &c. &c. | | | 8,000 | and 8,000 |
| | 1838, Wheat | do. | do. | 15,000 | and 32,000 |
| | 1819, Oats | do. | do. | 15,000 | |
| | 1838, Do. | do. | do. | 5,200 | |
| | 1819, Barley | do. | do. | 5,000 | |
| | 1838, Do. | do. | do. | 20,000 | |

Later returns show that while the export of wheat has gone on steadily increasing, that of barley has diminished, and been replaced in some measure by oats, *e. g.* :—

| | | | | Qrs. | Sacks of Flour. |
|---|---|---|---|---|---|
| In | 1844, Wheat exported by canal | | | 26,000 | and 19,700 |
| | 1846, Do. | do. | do. | 20,000 | and 23,000 |
| | 1844, Oats | do. | do. | 13,000 | |
| | 1846, Do. | do. | do. | 10,000 | |
| | 1844, Barley | do. | do. | 9,000 | |
| | 1846, Do. | do. | do. | 8,000 | |

The mode of preparing the land for the turnip-crop does not differ from the practice of other turnip-land districts, and therefore does not require any notice further than that, as soon as other husbandry operations permit, the plough is everywhere at work in this district in the autumn, turning in the wheat-stubbles, and thus preparing for a reception of the winter's frost.

It has not been the rule hitherto to plough the stubbles deeper than 4 inches, even on the deep soils.

The ploughs ordinarily in use are the two-horse swing-ploughs. Within the last eight years, indeed ever since the first publication of experiments on this subject in the Journal of the Royal Agricultural Society of England, ploughs with two wheels (such as Ransome's N. L., &c.) have been gradually introduced in some parts of the Wolds, especially in the neighbourhood of Driffield; so much so that, in a circuit of six or seven miles to the N. and W. of that town, they may be said to have superseded the use of the swing-plough. It is found that with quick-stepping horses in good condition it is as easy to do an acre and a half a day with the wheels as an acre with the swing-plough.

The subsequent culture of the turnip-crop, as it was derived from, so is it carried on according to, the Northumberland system. Mr. Strickland says, "It is but of late years that the true system

of hoeing and thinning the crop has been generally adopted, and but just now (1812) that the perfect management practised on each side of the Tweed, of sowing it on one-bout ridges, at the distance of about 26 inches between the rows, and 9 inches from plant to plant, is coming into use."

Drilling has now become universal. No such thing as a field of turnips sown broadcast is to be seen. The ridge-practice, however, except where swedes are sown (and this probably does not constitute more than one-tenth of the whole turnip acreage), is now superseded by the custom of drilling on the flat. More than one cause has contributed to this. The use of bones and other hand-tillages introduced the practice, because, as the bones and turnip-seed are generally drilled together, it became unnecessary that the land should be previously formed into ridges. It was also very obvious that, upon the dry shallow soils of the Wolds, the mode of drilling upon the level, and immediately afterwards of rolling the land with a smooth iron roller, was much more calculated to insure an early brairding of the plant, and to secure it from the fatal effects of drought, than when the land was ridged, and consequently when more surface was exposed to the sun's rays. And this the experience of succeeding years has entirely confirmed. It is even probable that, on the heavier Wold soils, and where swedes are grown, the ridge-system will be abandoned, and a method will be adopted which shall permit the application of fold-yard manure and the drilling of seed on the level.

The following statement has been furnished by a practical Wold farmer:—

"The turnip-crop has many enemies to contend with in its early stages, especially *drought* and *fly*. Mine is a heavy soil, and well adapted for swedes. I used always to ridge my swedes; and I applied 10 or 12 loads of good fold-yard manure per acre, nor did I ever sow the seed until the land was fit. Spite of all this, in a dry time, although the seed did vegetate, yet the young plants could not get on; and, if the fly attacked them strongly, were almost sure to be cut off. If it was a *very* dry time, the seed would lie in the ground until rain came, and then they never did so well as if they had come up at once. It seemed to me that this was mainly owing to the ridging plan. The land, according to this plan, got so many turnings and splittings—first in making the ridges, then in closing them after the manure, and last of all in drilling the seed—that all moisture was gone; and unless a shower of rain came just at the right time, my hopes of a crop were gone also. Therefore for the last two years I have done thus:—I endeavour to have my stubbles ploughed by the end of November. In the month of March (or earlier if frost should come) all the manure that is wanted for the crop of swedes (viz. according to the rate of 10

or 12 loads per acre) is carted upon the land in small heaps; it is then spread broadcast by hand as evenly as possible, and then ploughed in: if the manure is real good short muck, there is no difficulty, though a little care is needed in accomplishing a complete covering of the manure. The land afterwards undergoes the requisite number of draggings, harrowings, rollings, &c.; and I have always found that as the soil works up the manure works down, so that, when we want to sow turnip-seed, there is none or next to none of it left on the surface. The seed is drilled on the level at 27 inches apart. First, I used 1 quarter of bones per acre, to give the young plants a start; last year I tried 4 tons of bones dissolved in sulphuric acid, and had a very good crop. I consider this a safer plan for our land than ridging."

It is evident that the 60 or 70 bushels of bones per acre, at 2*s.* per bushel, spoken of by Mr. Strickland as the custom of his day, must have confined the application of them either to the affluent farmer or to a very small portion of the farm. It was consequently several years before it became credible that so small an amount of tillage as 2 quarters of ground bones per acre was sufficient to secure a crop. This, however, has proved to be a very valuable discovery; for even in the most remote and inaccessible parts of this wide area, one waggon is able to convey a sufficient quantity of crushed bones to manure 7 or 8 acres of land, according to the above proportions. It is about sixteen or seventeen years since the Wold farmers became convinced that a smaller quantity of bones than 2 quarters an acre would be sufficiently efficacious; and from that time until within the last year or two 12 bushels has remained as the ordinarily prescribed allowance.

In the year 1846 experiments of using 4 or 5 bushels per acre of ground bones dissolved in sulphuric acid were partially made; their success induced an extended trial in 1847.

The following statement has been forwarded on this subject:—

"I have been induced in the present year (1847) to try the use of superphosphate of lime on an extensive scale on my wold farm. There is not more generally than 3 or 4 inches of available soil above the chalk-rock; in some parts there is chalky gravel almost to the surface; hitherto from 12 to 16 bushels of bones has been the presumed requisite for an acre. In 1846 I tried an acre or two with 5 bushels of dissolved bones, and it answered so well that I determined to risk the whole crop of 1847 with a similar quantity. The cost, &c., was as follows:—

| | *s.* | *d.* | |
|---|---|---|---|
| 5 bushels of bones . . | 12 | 6 | |
| 4 stones of sulphuric acid . | 5 | 0 | |
| 1 quarter of malt combs . | 6 | 0 | |
| | 23 | 6 | total cost per acre. |

In many cases ashes had been used, or burnt earth, as an absorbent, and for facilitating the deposition of the seed. I was resolved, however, although at a higher cost, to substitute malt combs, and the result has answered my expectations. Last season, as is known, has not been generally favourable to the growth of turnips; in some localities the crop has totally failed: it is not so on the wolds. As considerable doubts have been expressed that turnips grown on wold soils with only the above small amount of inorganic matter would prove defective, I have been accurate in ascertaining the nutritive value of a crop of mine grown with it; and I find that in this present month (December, 1847) 240 sheep folded on the land consumed 1 acre of turnips in seven days."

This compound, then, promises to be a very important adjunct to the turnip culture of the Wolds.

Very great attention is paid by the turnip-growers to the period of hoeing. It is customary to let this operation by the acre: 3*s.* 6*d.* per acre has been the average charge of late years for finishing the job. The labourer who undertakes it performs the work by using a 9-inch hoe himself, and is followed by a child of 10 or 12 years old to single out the plant. If the farmer should not find it convenient to let the whole crop, then women are employed for the purpose, and it is thought that they are more adroit at this work than men: their wages, when so employed, are usually 1*s.* per day. Previous to hoeing, the use of the one-horse scuffler is needed, not only to extirpate surface-weeds, but to aid the operation of hand-hoeing; and before the turnip-leaf is much expanded, it is always thought desirable to run the scuffler through the rows once again.

Where it is intended that wheat should succeed turnips, a practice which is becoming general here, it is necessary that they should be eaten by sheep as soon as they have attained even a reasonable maturity. In such cases the red Tankard, being a variety of quick growth, is often selected for a crop. The old adage in reference to turnips (not swedes), that they should be sown astride the longest day, is then disregarded, and the seed is put into the ground not much later than at swede seed-time, viz. any time after the 20th of May.

From the 10th to the 20th of October is the time when the ewes are put to the ram, and long experience has proved that the prolific qualities of sheep are increased by their being fed upon succulent food during this period. Rape is preferred for this purpose where it can be grown; but where this cannot be, it is the custom to put the ewes and ram together upon the turnip-crop at this time.

On some of the large farms of this district the practice of

winter-feeding a few cattle has of late years prevailed; and it is greatly to be desired that this most important means of adding to the resources of the farm were more generally adopted. It has frequently been adduced as an impeachment of the otherwise improved husbandry pursued throughout this district, that the Wold farmers do not appear to know how to convert their straw into manure. It is remarked that huge piles of straw may be seen, perhaps half a mile from the homestead, left for months on the very spot where a portable machine has thrashed it, in all the disorder occasioned by that rather disorderly process: that even in the stack-yard no care is taken by stacking it, much being wasted by the wet, much by the wind. It is to be feared that these allegations are too just, and that great loss is really thus sustained. The benefits which are to be derived from a contrary course are too obvious to need comment. It is therefore to be hoped that, as years pass on, and knowledge is extended, these cases of negligence may become rare, that economy of straw may be the rule, the waste of it the exception.

In those large establishments where winter-feeding is carried on, it is never thought right to draw off for the cattle more than a certain proportion, perhaps one-sixth of the crop. The beasts are fed in yards loose, which yards are protected by shedding from the N. and E. winds, and the turnips are given them in square troughs or tumbrils. The great advantage of an additional allowance of 5 or 6 lbs. of oil-cake a-day to each beast has been recognised by several of the farmers; and thus, within the last few years, many prime fat cattle have found their way from this formerly barren waste to the fat-stock markets of Beverley and Driffield.

A fortnight fair has within the last two years been established at Driffield, and during the winter months it is well supplied with both beasts and sheep.

If the weather should be dry enough, and there should be no impediment by frost or snow, the plough follows close upon the sheep-fold, preparatory for spring-corn sowing.

It has become the practice, as has been observed, to sow wheat after turnips: upon the deep Wolds this may be said to be universal. The reason why the earlier mode of wheat after seeds has been abandoned is this, that on these soils, and in this climate, the wheat-plant was found to be very apt to be turned out in the spring, if sown on clover-lea, and that no system of rolling or of treading with sheep could counteract this tendency. Upon these soils also wheat of a finer quality is obtained after rape or turnips than according to any other method. Upon the thin Wold soils the very converse of this takes place: wheat after turnips does not

here succeed well; the quantity per acre is invariably found to be deficient; and although circumstances may demand at times a deviation from the established course, and oblige the farmer to take a turnip-crop preparatory to his wheat, yet it is only compensated by the so-called freshness introduced into his routine.

According to the Norfolk type, oats or barley follows turnips.

*Oats.*—This crop is now, as has been shown, the chief spring-corn product of the district. Reasons might be assigned, such as climate, soil, &c., why the cultivators have ceased to think with Mr. Strickland, that "few districts are better calculated for the growth of barley, and few grow it in greater quantity or perfection, than the Yorkshire Wolds." Another cause must be adduced, however, to explain why the one crop has in great measure supplanted the other. It has been found, and experience has caused the fact to be received as a law, that the continued growth of barley is, on these soils, detrimental to the succeeding wheat-crops; that where barley has been continued uninterruptedly through three or four courses, the wheat is subject to night-ripen, as it is provincially termed.

The symptoms of this disease are not apparent until the wheat begins to ripen; then it is that, in small circles or patches throughout the field, the straw, instead of becoming bright and glassy, assumes a dull, dead appearance; the ears are found to be quite deaf, and the stems to have lost all root-hold, so that they may with the greatest ease be pulled up. The cause of this decay may probably be found in the fact, that the long succession of barley-crops has drawn too largely upon the resources of the soil, and has removed those very constituents which the wheat-crops require for their maturity, and that no equivalent has been provided in the customary culture. This, however, is hardly the occasion to discuss chemical causes, or even to suggest chemical remedies. It is sufficient to say, that Wold farmers have thought it more desirable on thin soils to grow oats rather than barley, or at least to take two courses of oats to one of barley; and they are unanimous in the opinion that in this way they find the best security against night-ripening.

The time of sowing oats seldom commences before the middle of March; from various causes, it is sometimes impossible to complete sowing oats before the middle of May; but good crops are seldom obtained by sowing so late as this.

Tartarian oats, of the black variety, are much in vogue now; white Tartarians are also grown and approved; and some of the early Scotch varieties, such as Angusshire, Hopetoun, &c., which are of the kind usually termed potato-oats.

*Quantity of seed per acre.*—On the deep Wolds the best farmers

persist in the opinion that it is not desirable to sow less than six bushels per acre, especially of the Tartarians; on the shallower soils not less than four bushels are sown. Experiments on this much-debated question have been recently instituted with respect to wheat as well as oats, and they will probably be read with interest in the appendix to this report, which has been furnished by Mr. Fleetwood Shawe, of Brantingham Thorp.

The land for spring-corn sowing only receives one ploughing; and whatever may be the opinion as to the propriety of deeper ploughing for a turnip-fallow, yet for spring, either after the winter-eatage of turnips or after clover-seeds, it is never the practice on the Wolds to plough deeper than from 3 to 4 inches.

Just before the young plants of oats or barley appear above the ground the custom is to sow clover-seeds. And here it may be remarked how very much it conduces to the future well-doing of this very important plant, that the soil should have previously been well pulverized.

It has been observed, in respect to the question of clover-failure, that upon headlands, however defective may be the remainder of the field, there is seldom a want of clover-plant; and this has been attributed to the greater solidity imparted to the headland by the extra rollings, turnings, treading of the horses, &c. This is undoubtedly true; but very much is also due to the extra pulverization which the land here receives. It would be well that farmers bore this in mind, and that as much pains were taken in producing this sort of tilth as the season would admit of.

Where clover alone is wanted for soiling, or for making into hay, about 21 lbs. of it (Trifolium pratense) are sown per acre—the after-grass of it is then depastured by sheep or lambs; but where clover-seeds are required for summer-pasturage, the usual quantity per acre is 1 st. white clover (Tr. repens), and 1 st. of trefoil (T. officinale), rib-grass, and parsley (Apium graveolens).

Sowing these light seeds by the hand in this bleak and exposed district is found to be attended with some difficulty and irregularity; consequently a drill has for some time been in use, for which, as for other implements, the farmers are indebted to their Northumberland brethren. It consists of a sort of covered trough, 12 feet long, through which an axle passes, provided at intervals with small brushes, and to which action is given by the travelling-wheels; it is raised about 18 inches above the surface of the ground, and it is found that by this simple means the seed is deposited with great regularity. In this way a man and horse can finish off nearly 30 acres a-day.

Within the last eight or nine years another rather more complicated clover-seed drill has been used in the district. It is arranged

on the principle of a coulter-drill, so that the seed can be sown in rows 3 inches apart, and about 2 inches beneath the surface. At first it was thought there was much advantage in thus sowing the seed at a uniform depth, and that by the spreading of the plant all marks of the rows would in the following summer be obliterated. In practice, however, on the weak Wold soils at least, this is not found to be so. Owing to the seed being too much crowded together, the traces of the drill are never entirely lost, the plants are found to be not so vigorous as should be, and therefore this mode of drilling is not so much used as formerly.

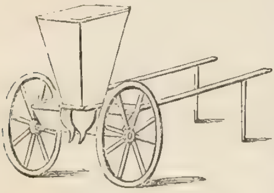
Although an admixture of rye-grass amongst the clover-seeds cannot be said to be a general practice on the Wolds, yet many farmers affirm the utility of it, and of these, it must be admitted, there are some who are distinguished for their general superior style of farming. They contend that rye-grass furnishes the earliest spring-food, and is therefore most valuable for their ewes and lambs during that hungry period which occurs betwixt the finish of the turnips and the growth of the clovers. That in this way rye-grass is very valuable there is no doubt. It may be questioned, however, whether this advantage is not counterbalanced by the detriment occasioned by it to the succeeding white corn-crops, by the violation of the well-known rule that crops of the same genus should not succeed each other.

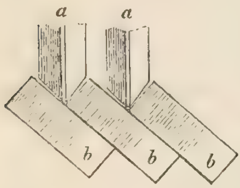
The most experienced farmers of this district think it advisable to apply nearly the whole of their fold-yard manure to the clovers, growing their turnips with hand-tillages, such as bones, guano, superphosphate, &c. By many it is thought that the most fitting time for putting manure upon the clovers is in the autumn, immediately after the field has been cleared of its grain. Many, on the other hand, persist in the practice of deferring to manure the clover-lea until within a month or six weeks before sowing it with wheat. In favour of the latter way it is argued, that wheat upon poor Wold soils requires much encouragement; that the vegetable matter afforded by the clover-lea may provide pabulum to the young plant during its early progress, but that on these soils there is a lack of nutrition in the spring-time, when the tillering process begins; and that this nutrition is best supplied by having well manured the ground a month or so before seed-time. In support of the former system it is urged—and here it will be observed that practice is coincident with science—that fold-yard manure should in all cases be applied to green and not to grain crops; and further, that a good covering of fold-yard dung serves to protect the young clovers from winter frost; that a luxuriant summer pasturage is greatly promoted (if not altogether secured) by a previous autumnal manuring; that at all events none of the

advantages which are supposed to flow from the contrary practice can justify the certain loss which is sustained by manure being exposed to the wind and sun of July and August.

*Wheat-sowing.*—Where wheat follows clover-lea, it is found, on the higher parts especially, advisable to sow it as soon as possible after harvest is finished. Consequently seed-time may be said to commence in some seasons in this district at the beginning of October. The land gets but one ploughing; a furrow-slice 9 inches by 4 is about the average.

Until within the last eight or nine years the drill was universally used for sowing wheat; and the way was to harrow, first along, and then athwart the ploughed furrows, and then to drill the seed at about 7 or 8 inches apart. Within this period, however, the drill-presser, or iron land-presser, with hopper affixed, having an apparatus for depositing seed and tillage, has come very much into use, and has been much approved. It has sometimes three pressing wheels, but more commonly two. If the latter, it of course follows and covers the work of two ploughs. The diameter of the wheels for Wold work is about 3 feet 6 inches.






The annexed diagram represents a section of the rim of the pressing wheels, *a a*, and of the furrows, *b b b*, just at the point where the furrows overlie, and pressure is imparted.

A light seed-harrow is frequently hung on to the implements, for the sake of covering the seed from the depredation of birds: where this is done, the work is finished off in a very complete manner.

Some farmers are not content with the amount of pressure which their light lands receive from this implement, but give it a rolling also with Crosskill's clod-crusher after the seed is sown. Nor can this be said to be superfluous. The danger to be dreaded in this climate and soil is that the wheat-plant should be thrown out in the spring. The perilous time is the month of March, when frosty nights and sunny days succeed each other frequently for weeks together, and then the soil becomes so light and pulverulent that the wheat-roots loose their hold, and many die away. No machine that has yet been invented seems so well calculated to provide a remedy for this as Crosskill's clod-crushing roller. It is not ordinary rolling that it gives; the points of the serrated

rings of which it consists so act upon the surface as to embed it down more firmly than ordinary rolling is able to do. It should be repeated, if the land be dry enough, in March.

Where manuring the clovers is practised, it might be thought that this is enough, on all soils that are worth cultivating, to secure a fair crop of wheat, and that any addition of foreign tillage were unnecessary. It has been found, however, that upon some weak gravelly soils of the Wolds it is almost impossible to bestow too much *fertilization*, so much so that instances might be named where, in addition to the 10 or 12 tons of fold-yard manure that have been applied to the clovers, rape-cake dust, or soot, or guano has been put upon the wheat in the month of March or April, and the result has been an increase of at least 1 quarter of wheat per acre. If rape-dust be used, the quantity is generally 12 bushels per acre, which at 2*s.* 6*d.* is 30*s.* per acre.

If soot, 6 bushels weight, at 4*s.* per bushel = 24*s.* per acre. A mixture of guano and nitrate of soda has, it is said, been tried with effect, viz. 12 st. guano to 6 st. nitrate of soda, at a cost of 25*s.* per acre.

Mr. Strickland calculates the produce of wheat on the Wolds at from 12 to 24 bushels per acre. At present it may be affirmed to be from 24 to 32 bushels an acre.

*Seed Wheat.*—There is no sort of wheat that has found more favour on these soils than the Old Red Kent, or Creeping Wheat. It has maintained its character probably longer than any other, and is thought to be well adapted to the climate; suffering, as it apparently does, less from moisture and mildew than others. Late years, however, have been so fruitful in new varieties of this grain (and there is no description of experiment that farmers are so prone to as that of a new wheat), that it is somewhat hazardous, in our present state of knowledge, to point out any one description of wheat as more suited for the locality than another. Of white wheats, Hopetoun and Hunter's White, are much approved.

The harvest operations of the Wolds form a very important part of its husbandry, and therefore merit notice.

It is the invariable practice, it may be said, of the Wolds, to mow all the white corn-crops; on the other hand, in the Vale of York and in Holderness, the use of the sickle nearly equals that of the scythe. The Wolds being an extensive corn-growing district and thinly inhabited, farmers are dependent upon the aid of strangers to complete their harvest. Irish labourers are little employed here, as they are unused to mow. The hilly district to the north and north-west of the county furnishes usually a supply of labourers for the purpose of harvest. These men—Dalesmen, as they are termed—are very expert in the use of the scythe.

An average-sized Wold-farm requires five or six scythes: each

scythesman must have two followers, viz. a gatherer and a binder. The corn is always mown inwards; in other words, the mown swathe falls towards the standing corn; it is then immediately gathered and bound by the two followers, who are precluded from loitering or delaying their work by the fear of being overtaken by the succeeding scythe. In this manner the process must necessarily be continuous and uninterrupted; and thus, if a good hand is put at the head of the gang, as much as two acres per scythe is easily accomplished in the day. A stooker and raker complete the party. The labourers are generally engaged for a month or five weeks, and are boarded with the farmer. It is not uncommon, however, on the smaller farms of the district, and very usual in the lowland parts, to let harvest-work by the acre.

On some farms Scotch single-horse carts are used for carrying home the corn, but more commonly waggons: these waggons are of a construction somewhat peculiar, and have been in use many years. In harvest, two horses are yoked to them; for delivering corn to market, &c., four. Where four horses are used, they are yoked, just as if put to a coach, the wheelers drawing by a pole, the leaders by splinter-bars. The driver is mounted on the near-side wheel-horse, and guides the team by reins, after the fashion of the German post-waggon; when empty they are thus able to trot along a good road at the rate of 6 miles an hour; and when loaded, the horses, being near their work and conveniently placed for draught, labour more efficiently than when yoked at length.

Excellent as the practice seems to be, and greatly as it has been recommended by persons of high authority, yet scarifying wheat-stubbles has not obtained on the Wold, except in some few instances.

*Sainfoin.*—This plant, which in former years was held in high estimation, and which was said by Mr. Strickland to be an object of great and increasing cultivation in this part of the county, is now not much grown. In times when winter provender was a matter of anxious consideration to the Wold farmer, and when turnips were either untried or considered of precarious culture, then indeed a plant which would flourish where scarcely any other plant would vegetate, seeking its nourishment from the tap-root, and therefore peculiarly adapted to porous calcareous soils, was highly esteemed; and it is not surprising that its introducer into this Riding should have been hailed as his country's benefactor.* Now that turnip-husbandry, however, has become established, and the alternate system of cropping is universally adopted on

* Said to have been introduced by the Osbaldistons of Hunmanby, about the year 1740.—*Strickland*, p. 145.

the Wolds, sainfoin has lost its original value. A field or two of it may here and there be seen, distinguishable from afar in the month of June by its beautiful scarlet flower; but it is of rare occurrence, and confined either to very gravelly soils, or bare and craggy knolls. The late Sir W. Strickland was an extensive sainfoin grower, and a zealous advocate for its extended cultivation. By his treatment of it he was in the habit of obtaining as much as two tons of sainfoin-hay per acre: he greatly deprecated the practice of eating the after-growth of it bare in the autumn, either by sheep or any other animal; because it was found that by this means the crown of the plant was exposed to winter frost, and that the crop would not thus survive more than six or seven years; but that, on the other hand, by being content with the produce obtained from the scythe only, it would flourish for twenty years or more.

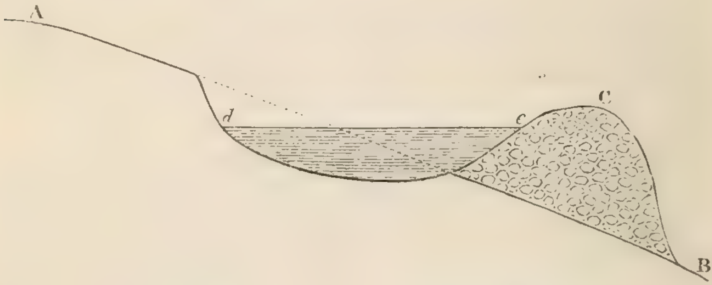
*Wold Ponds.*—In a wide area like this, destitute almost entirely of land-springs, pond-making is considered a very important art. There is no part of the kingdom perhaps where it has received more attention than in this; it therefore demands notice.

These ponds are always made circular.* The common dimensions are from 18 to 20 yards diameter: there are some even more than this; one, in Sledmere Park, is 30 yards diameter. If, however, the diameter be 20 yards, the central depth should be 8 feet; and so in like proportion, the slope being gradual. The ordinary locality selected for a pond is by the side of a road, for the sake of catching the water flowing down the ruts in heavy rain. This plan, however, is condemned by experienced men: a better way, they say, is to construct the pond where there can be no such influx, and where its filling is made dependent entirely upon the fall of rain or snow from the heavens—that the land-floods bring with them a great quantity of larvæ of insects of various sorts, worms, &c., which eventually penetrate through the clay bottom, and destroy the pond, besides the deposit of silt, sand, and gravel, which tends to fill it up. The spot selected should be such as to serve three or four fields, if possible, on the table-land of the hills. When the necessary excavation has taken place and the proper depth been obtained, the first thing is to cover the whole surface with clay, well rammed down to the thickness of 4 inches, then cover with an inch of quick-lime, then a layer of straw, and then broken chalk over the whole from 18 to 24 inches in thickness. In general ponds thus made are considered complete; an improvement, however, has been made in them lately, which may be mentioned, viz. the making a trench, or *cess*

* They are said to have been first constructed, according to this form, by Robert Gardner, a native of Kilham, in the year 1775.

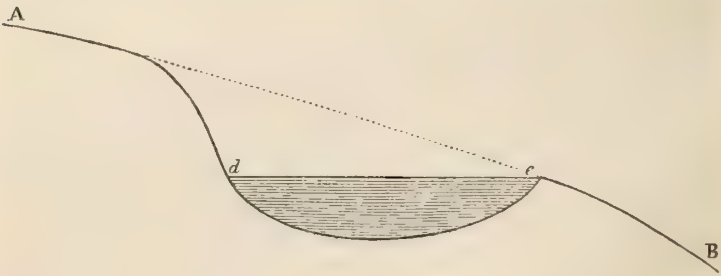
as it is termed, around the external circle of broken chalk, 3 feet deep and 3 broad. This trench must be filled with chalk rubble; and the object is to give a firm standage for cattle drinking at the pond, and to prevent the ill effects of their trampling and displacing the edges.

If it be necessary to make a pond on the slope of a hill, then the method recommended by Sir Tatton Sykes, of Sledmere, is worthy of consideration. The common way of making a pond in such a case used to be thus—




A to B, the slope of the hill.
C, the chalk embankment for the lower edge, consisting of the excavated chalk.
*d* to *e*, water-level.

Now this, though convenient for the sake of disposing of the excavated matter, was found to be attended with the disadvantage, that the chalk embankment rarely obtained due solidity, and the water was apt to escape. The improved method may be described by the annexed section.




Here it will be seen there is no chalk embankment; the water-level at point *e* rests upon the solid undisturbed strata, and therefore there is less risk of leakage. The excavated materials are entirely carted away—at some additional cost certainly; but a cost which is well repaid by the security of the pond holding water. It is thought that the Wold ponds made in this way, and once

filled, will never again be empty. The large one in Sledmere Park was apparently little affected by the drought of 1847, a year in which less rain fell than in any year of the present century.

*Of Chalking.*—The use of chalk as a top-dressing, which extensively prevails in other parts of the kingdom, is not unknown on the Wolds. It has, within the last 10 years, been applied to parts of the deep Wolds, and has been found beneficial in correcting the so-called *sourness* to which these soils are liable. On the northern range of the Wolds, viz. on that long range which extends almost unbroken from Settrington Beacon to Hunmanby, the crops are found to suffer much from two causes; first, from a noxious weed, locally termed Perry (Spergula arvensis), which so infests the corn-crops as almost to destroy them, and also from the well-known disease, which attacks turnips, called Fingers and Toes. In both these cases chalking has been found completely efficacious: from 80 to 100 cubic yards per acre are laid on in the autumn or winter, dug from pits in the centre of each field, and not taken from any great depth, so that the pit can afterwards be filled up, and the land again cultivated. It is found desirable that the chalk shall be dug up at a time when it is most saturated with water, that the frost may the more readily act upon it and pulverize it.

*Live Stock.—Sheep.*—The Wolds have, no doubt, from time immemorial, been considered a sheep-breeding district; and it is probable that the quality of the animal fed and bred upon it was proportioned to the prevailing condition of the district: for we find, according to Arthur Young, in the year 1777, when open downs and pastures were its characteristic, that the Wold breed of sheep was a small, hardy, compact animal, accustomed to travel far for its food, and producing a short, thick, close fleece of wool, which enabled it to resist the cold of the climate; that when fat (which was not till four years old) it weighed 12 or 14 lbs. per quarter, and the fleece weighed 3 lbs. at a medium, worth, at the price of the period, about 2*s.*

Subsequently an attempt was made to increase the size and wool of the animal by introducing a cross from Lincolnshire: the two races, however, were so dissimilar in qualities, that the admixture of blood did not succeed, and the breeders soon found out their error, and they substituted the Leicester for the Lincolnshire ram. By this means they improved the wool and produced a more correct form, with a greater aptitude to fatten. At the present day the breed of Wold sheep may be said to be essentially Leicester. That this breed is thought to be the best suited to the district may be inferred from the fact that the oldest and most eminent ram-breeders (among whom may be named Sir Tatton Sykes, of Sledmere, and Mr. George Robinson, of Carnaby)

have, for a period of near fifty years, selected their rams from no other flocks than those of the Leicester breeders, who have been most famed for the purity of the blood and general quality of their stock, *e. g.* Messrs. Buckley, Stone, Burgess, Paulett, &c.

Sir Tatton Sykes, from his early and zealous attention to agricultural matters, and especially to sheep-breeding, may be said to have fixed and established the character of the Wold sheep. His own flock are rather small in size, but highly symmetrical, with a great inclination to fatten. Mr. Robinson's sheep are of a larger mould; and they are held in high estimation, not in this Riding only, but are sought after from distant parts of the country.

An attempt was made several years ago, by the late Mr. Osbaldiston, of Hunmanby, and by Sir William Strickland, of Boynton, to introduce the breed of South Downs, and it was persevered in by these gentlemen for many years. It did not extend, however, to others; and at present this description of sheep is not to be found within this district, except in the hands of a few amateurs. Possibly a first cross with the Leicesters might not be unprofitable; indeed two or three cases might be named where this has been tried and approved of.

The ewes, as has been said, are put to the ram about the second week in October; and, wherever practicable, are at this season fed upon rape or turnips. The most usual way is to turn the ram loose in a fold of about 80 ewes. Ram-breeders, however, practise the mode of *stocking* their ewes, the details of which it is unnecessary to describe here: others than ram-breeders have also latterly tried the system, and have thought that it answered sufficiently well to repay the extra cost and trouble. After the ewes have been with the ram about six weeks, they are taken off their succulent food, and are put upon old grass: this, of course, must depend upon circumstances, for in many Wold situations there is no old grass; and here the turniping must be continued throughout. In others, hill sides and remnants of old sheep-walk are available for such purpose: and here the ewes are found to thrive very well, until the beginning of February, when they are again placed upon turnips, with a view to promote a due supply of milk in the animal. It has been recommended by persons of good authority on these subjects, that at this period of their gestation some dry food should be given with the turnips, such as bean or pea meal, or oil-cake. This has already been tried by some farmers in the district, and the effect is well spoken of.

Subject as these hills are to heavy snow-storms, frequently as late as April, and destitute of shelter as some parts of them are, lambing time is a very anxious time to the farmers, and requires

the greatest care and attention on the part of the shepherd. Those ewes which are nearest to lambing are brought every night into the stack-yard, or some sheltered part of the homestead, and are served with cut turnips. The ewe and her produce run together upon the summer pastures of clover, &c. until the middle or end of July, when the lambs are weaned. Great losses are apt to take place among the lambs at this time. Nothing is found to be a better weaning pasture for young lambs than the aftermath of either sainfoin or clover.

The management of the lambs, or hogs as they now begin to be called, is various. They, whose object it is to bring them to early maturity, commence the forcing system immediately. First, as soon as possible after the weaning they are put upon rape, after that they are taken to turnips, which turnips are cut for them and put into troughs; and in addition to this an allowance is made to each hog of ½ lb. of oil-cake or a pint of barley a day.

This sort of forcing cannot be said to be in general usage: it involves a little more capital and rather more confidence in results than falls to the lot of the majority of farmers; yet it has been strongly contended that it is a profitable system—that the outlay in oil-cake, &c., if not recoverable in the market-price of the animal, never fails to show itself in the succeeding crop of corn—that if the Wolds are to be cultivated at all, they cannot be profitably farmed unless under such high culture. In such cases the wether-hogs attain to a weight at shearing time averaging as much as 22 lbs. a quarter, and are then sold to the butcher. But those who prefer the simpler routine are content to give their wether-hogs turnips only, and by this means they are kept in a thriving growing condition, and are held over the succeeding summer ready for the autumnal fairs, of which there are three in the neighbourhood, viz. Market Weighton, Sept. 25; Malton, Oct. 11; and Pocklington, Nov. 8. Of late years not so many sheep have been exhibited at these fairs as was formerly the case; they have found their way from time to time, when fat, to the stock-markets of the West Riding; the facilities of locomotion have, in great measure, effected this.

*Cattle.*—Although the subject of cattle cannot be said to belong exclusively to the section of the Riding we are now treating of, yet it will be more convenient to treat of it here.

In Mr. Strickland's time, "the Holderness or short-horned breed, remarkable for their large size and abundant supply of milk," were said to prevail universally throughout the East Riding. This breed of cattle does not seem to have been indigenous, but to have been introduced at some early period from

Holland and the north-western parts of Germany. Their colour is described as being generally red and white, or black and white, and in some cases mouse or dun colour on a clear white ground. The great amelioration, however, which began to take place about forty years ago in the class of short-horned cattle on the banks of the Tees, has now extended itself into the East Riding. Bulls and cows of a finer description, of the stocks of the accredited northern breeders, have found their way hither, and have caused the old Holderness sort to disappear.

It may, perhaps, have been remarked, that the cattle of this Riding, especially of Holderness, are of a large frame, and possess propensities to milk rather than fatten. It is to be doubted, however, whether this has not proceeded from the taste of the stock-owners, rather than that any remnant of the old stock still exists.

No part of the East Riding can be called, as it was in 1812, "an entirely breeding and grazing country." In Holderness two-thirds are probably under the plough. The Vale of York possessses very little land with grazing qualities. The Wolds, as must be known to all who are conversant with chalky tracts, are more adapted for sheep than cattle. Consequently it is found that few farmers keep a larger dairy than is sufficient for the wants of their family. Mr. Watson, of Waudby, near South Cave, is an exception to this: he possesses a herd of from 50 to 60 short-horned cows, and the prices he is in the habit of obtaining for his yearling bulls, &c., prove the esteem in which his stock is held.

The propriety of economizing the straw of a farm, and of converting it into good manure, has been alluded to, and the defect observable in this particular in Wold farms has been pointed out. This defect, however, is not confined to the Wolds. The management of straw-fold cattle throughout the Riding is capable of great improvement. If a small allowance of turnips, or of oil-cake, or of the linseed compounds so much in vogue now-a-days, were given in addition to the straw, a very important benefit would be conferred, not only upon the fertility of the individual farm, but also upon the resources of the whole community.

*Horses.*—This part of Yorkshire has long been celebrated for its breed of horses, and this celebrity in some measure continues. The Yorkshire bays are still in request for London carriage-horses, and most of these are bred in parts of Holderness, in the neighbourhood of Burlington, &c.

Formerly a large, powerful, bony animal was required for carriage purposes: the fashion of the present day has, however, changed in this particular; and now it is necessary that the London carriage-horse should be three parts, at least, thorough-bred. Consequently, all traces of the original pure coaching breed, or

Cleveland bay, as it was termed, are nearly obliterated. At Howden fair, which takes place the last week in September, three-year-old colts of this description are brought forward in considerable numbers to meet the demands of the London and other dealers.

There is nothing peculiar in the *draught-horses* of the East Riding. Some farmers adhere to the black cart breed—a stout large-framed animal—as being the best adapted for drawing heavy weights in single-horse carts. In general, the draught-horses are of a mixed character, and on the Wolds they are not without some infusion of blood, or at least of coaching blood; the chief desideratum on the light soils being activity in stepping.

*Condition of the Agricultural Labourer.*—There is no part of the kingdom where the wages of the agricultural labourer rule higher than in this Riding, as the following statement, applicable to the present period, will show:—

"*Agricultural labour.*—Yearly servants with board and lodging.

| | | | |
|---|---|---|---|
| Foreman, from . . . . | £22 | to | £25 |
| Waggoner, from . . . . | 14 | to | 16 |
| Shepherd, from . . . . | 21 | to | 23 |
| Plough-lads, from . . . . | 8 | to | 12 |

Day-labourers with board.

From Martinmas to Candlemas, 7*s.* to 7*s.* 6*d.* per week.
From Candlemas to harvest, 7*s.* 6*d.* to 8*s.* 6*d.* ditto.

Day-labourers without board.

From Michaelmas to Candlemas, 12*s.* per week.
From Candlemas to harvest, 13*s.* 6*d.* or 14*s.* ditto.

Harvest wages with board.

Best mowers, 17*s.* per week.
Binders and stookers, 14*s.* ditto.
Gatherers, 12*s.* or 13*s.* ditto.
Harvest-work per acre, wheat 7*s.* 6*d.*
Grass-mowing per acre 2*s.* 9*d.* to 3*s.* with beer.

Thrashing per quarter, by hand.

Wheat, 3*s.* 6*d.*; barley, 2*s.*; oats, 1*s.*; beans, 1*s.* 3*d.*"

Of *cottage rents* it is impossible to give more than an approximation. Under a benevolent landlord there are instances of cottages with a rood of ground attached being let for 3*l.* a-year. Where the circumstances of the tenure are different, as much as 6*l.* a-year is obtained for similar tenements in villages purely agricultural.

The value of *keeping a cow* is so highly appreciated both by the labourers themselves and by their employers, that efforts are

now being generally made to facilitate this valuable acquisition to the poor man. The most independent mode is for the cottager to rent a small garth or close, sufficient for summer eatage and for hay in winter. These convenient holdings, however, are not everywhere to be met with. In lieu of this, therefore, it is not uncommon for either the lord of the manor or surveyor of the highways (to whomsoever it appertains) to let to the cottagers the right of eatage of the lanes, or herbage bounding the highways; and of which, on the Wolds especially, there is in every parish a considerable quantity. The letting of this is by public competition, and extends from Ladyday to Michaelmas. The purchase of a cow is, of course, a matter of no small difficulty to most labourers; not only are the savings of the thrifty absorbed by it, but those who have no such fund to resort to are fain to venture upon the rash expedient of borrowing. In either case the loss of the cow is a very serious matter; and therefore by some it is held to be inexpedient to encourage the labourer in the possession of stock of so precarious a nature. There are, however, two modes, at least, of guarding against such risk, and it is most desirable that village cowkeepers should be advised to avail themselves of one or other of these. The one is the Village Cow Club—the other, the Farmers' Cattle Insurance Company. Of the latter institution, its advantages having been extensively set before the public, it is unnecessary to speak. Of the former, the Village Cow Club, Mr. Strickland (p. 47) has treated at some length. It appears that efforts had been made by himself, and other benevolent individuals, to introduce into the East Riding this plan for insuring cows, which had been tried for some years in Lincolnshire, and had succeeded there. He gives rules for its management; the chief of which seem to be, that an *ad valorem* rate of a halfpenny in the pound per month shall be paid by the cowkeeper; and that when by this means a capital shall have accumulated amounting to 3 per cent. of the aggregate value of the cows insured, then the payments were to cease until the funds should be reduced by losses. There are, it is believed, very few instances at present in this Riding of the existence of one of the cow-clubs, which can only be accounted for on the general principle that institutions, however good in themselves, if they are merely local and dependent upon the zeal and activity of a few individuals, do not possess the elements of vitality. The great prevalence also of late years of pleuro-pneumonia, which, when it attacked the village herd, would go far to impair the solvency of the cow-club, may also have tended to their discouragement.

*Cottage Allotments.*—The benefit accruing to the labouring man from having a certain piece of land allotted to him, independent

of his cottage, seems to be recognised in this Riding, for since this system was first introduced* it has been much extended, and a desire appears to prevail to carry it out wherever practicable.

Generally it has not been thought desirable for the labourer to occupy more than 1 rood of land. There are cases, however, where cottage allotments exceed this quantity, and one instance might be named in the Riding where recently 14 or 15 apportionments of 1 acre each have been made to the labourers of the parish. It appears in this case that the land is of an extremely light and sandy nature, consequently it is as effectually tilled with hand implements as with the plough and harrow; otherwise it is clear that the occupation of this quantity of land would absorb more of the labourer's time than is desirable in a part of the country where wages are high and the demand for labour great.

In some counties the local agricultural societies have instituted cottagers' prizes, and have offered rewards, among other things, for the best cultivated cottage allotment. These prizes, it is said, have never failed to excite much competition, and to create considerable interest among the labouring classes; and it is to be wished that similar local societies of this Riding, of which there are four or five, should appropriate a small portion of their funds for a like purpose. These rewards consist usually of a small sum of money, and are accompanied by a card, having the prize-man's name printed on it in large letters; and there is little doubt that the honest pride with which the working man can point to this ornament of his humble mantel-piece, is not inferior to that of the successful competitor for the munificent premiums of the Royal English and other extensive Agricultural Societies of the kingdom, and, in its own sphere, is productive of results not less beneficial.

*Benefit Societies.*—Throughout this Riding there exist numerous benefit societies, bearing the title of Societies of Odd Fellows, Shepherds, Druids, Foresters, &c. Many of these are affiliated branches of institutions, which have their central government at some populous places in the manufacturing districts—Manchester, Newcaste-under-Lyne, &c.; but the management of their pecuniary interests is usually left to the parish or district, and no power, therefore, is in reality exercised by the central body; but it is to be regretted that, inasmuch as these societies have secret symbols, their affairs are not always conducted with such publicity

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* Cottage allotments, as a system, were first introduced into this Riding by the present Lord Wenlock, of Escrick Park, who, soon after he succeeded to the Escrick estate, viz. about the year 1823, among other plans for the amelioration of the agricultural labourer, established cottage allotments in each township on his property.

as might make them most generally advantageous, that the contributions of the poor are often wasted in needless display, and that their number interferes with the establishment of such a benefit-club for the Riding as, by securing the patronage of the landowners, might give the labouring classes the advantages of their co-operation.

The objects to be kept in view in such an institution would be twofold—first, security to each individual that he shall receive an equivalent for his deposit; and, secondly, such provision against the risks of life as may enable those whom Providence favours to assist their less successful brethren. The first is to be mainly attended to in a society which proposes to assign pensions after a certain age; the second, in one which gives relief in sickness: and these objects must necessarily interfere with one another. A well-constituted society for the first purpose should be founded on accurate calculations, and might have the same security as those insurance offices which are resorted to by the wealthier classes. It is to be feared that some societies in this Riding either require a disproportionate payment for such a return, or else are not sure of acquitting themselves of their engagements: for the terms of admission are not founded on an exact calculation of the age of those they admit, and can scarcely lay claim, therefore, to exactness. But most of those which have been mentioned aim at giving relief in sickness, an object of great importance, but very difficult to make accordant with the principle of security, because it can hardly be founded on accurate data.

The only expedient that could be adopted by way of blending the two objects would be, that, while the provision for age was regarded as a debt which the institution incurred, the safety of which must on no account be compromised, the scale of payments might be made somewhat higher than if this object only were contemplated, and a fund might thus be raised, out of which the society might act as a benefit-club for the relief of the sick, in addition to its main function as an insurance office. It might be wise, too, to give the poor every facility in borrowing, on the credit of the right they had gained by past payments, in case sickness should render it imperative upon them to anticipate the provision made for their age.

A society which aimed at such objects, and which had the support of persons of property in the Riding, would not only give security to the providence of the poor, and thus encourage habits of frugality, but it would augment the interest which binds together different ranks of society, and thus contribute to the security and happiness of the nation at large.

## APPENDIX.

The following communication from Mr. Fleetwood Shawe, it is hoped, will prove interesting, not only as presenting a type and model of a well-managed East Riding farm, but by the variety of its soils and culture, as furnishing useful practical details to agriculturists in general; whilst the value of these details is greatly enhanced by the accuracy and fidelity with which they are recorded:—

"*Brantingham Thorp, Jan.* 25, 1848.

"In compliance with your request, I proceed to give you some account of my farm; but previously it will be necessary to say something of its situation, soils, &c.

"This farm is situated at the south-western edge of the York Wolds, near the river Humber. It consists of 800 acres; 500 of which are arable, and 300 grass. The soil varies much on different parts of it; and so I must classify it into three distinct divisions: 1st, the wold; 2nd, the middle; 3rd, the alluvial portion. The 1st consists of about 160 acres of a friable soil, from 4 to 5 inches in depth, incumbent on the chalk rock. Between this and the 2nd portion there is a belt of Kimmeridge clay about 200 yards in width, consisting of 55 acres, all in grass. In the 2nd portion the soil varies considerably: that part adjoining the Kimmeridge clay being a deep rich loam, resting on a gravel; another part light sandy loam, reposing on the inferior oolite; and part a mixture of loam, sand, and peat, lying upon white or yellow sand: this division contains about 400 acres, nearly all arable. The 3rd portion contains 185 acres of alluvial soil, varying in quality, and increasing in fertility as it approaches the Humber: with the exception of 50 acres, it is all in grass.

"I shall now describe the system of cropping adopted on the different portions.

"*1st, or Wold portion.*

"1st year. *White Turnips.*—Drilled on the flat; rows 24 inches apart; manured with 12 bushels of bones and 24 bushels of Hull ashes per acre. Fed off with wether and gimmer hogs; the former receiving ½ lb. of oil-cake per day each, and all getting cut hay. N.B.—In 1847, 5 bushels of bones dissolved in 100 lbs. of sulphuric acid were used in place of bones 12 bushels.

"2nd year. *Barley.*—Drilled 9 inches wide; 10 pecks of seed per acre.

"3rd year. *Seeds*—viz. white clover, 14 lbs.; trefoil, 5 lbs.; parsley, 2 lbs.; common red clover, 3 lbs.; perennial clover, 4 lbs.—in all 28 lbs. per acre: sown after the barley is up, with a broadcast sowing-machine, and harrowed with very light harrows. After the barley is harvested, well-rotted fold-yard manure is laid on the seeds, at the rate of 8 tons per acre, spread by women, well bush-harrowed, and rolled with a heavy iron roller, which rolling is repeated in spring. The seeds are depastured with sheep.

'4th year. *Wheat.*—Drilled 9 inches apart. If weather permits it is rolled with Crosskill's largest clod-crusher, weighing $1\frac{1}{2}$ tons, immediately after sowing, and again in spring. As soon as the wheat-crop is off the ground, one field of 20 acres is ploughed and sown with common rye, broadcast, at the rate of $3\frac{1}{2}$ bushels per acre, to be fed off in early spring with ewes and lambs; the land is then ploughed, and sown with white turnips.

" The land on this portion is apt to tire of seeds, and every effort has been made to find substitutes. Peas, rape, and tares have in turn been tried; but no crop hitherto discovered is so likely to give a full plant of wheat as good seeds.

"*2nd, or Middle portion.*

" 1st year. *Swedes, or Hybrid Turnips.*—Sown on ridges 26 inches apart; manured with 8 tons of fold-yard manure, 1 cwt. of Peruvian guano, and 24 bushels of Hull ashes per acre. One-third or one-half led off to fold-yards; the rest consumed by sheep.
" 2nd year. *Barley.*—Drilled 9 inches apart; 10 pecks of seed per acre.
" 3rd year. *Seeds.*—21 lbs. white clover trefoil, perennial red, and parsley, broadcast.
" 4th year. *Wheat.*—Drilled 9 inches apart; 8 pecks of seed; clod-crushed as above.
" 5th year. *White Turnips.*—Drilled on flat 24 inches apart; manured with 12 bushels of bones and 24 bushels of Hull ashes. One-fifth led home to fold-yards; the rest consumed on the land by sheep.
" 6th year. *Oats.*—9 inches apart; 12 pecks of seed per acre.
" 7th year. *Seeds.*—As above; manured after oats are harvested with 8 tons of fold-yard manure per acre.
" 8th year. *Wheat.*—As above.

"*3rd, or Alluvial portion.*

" This, previous to being drained, was in ridge and furrow, the lands being 12 feet wide; and the system pursued was—

1. Fallow, manured,
2. Wheat,
3. Beans,

or,

1. Fallow, manured,
2. Wheat,
3. Oats,

" Within the last few years I have drained it, down the alternate furrows, with tiles and flats 20 inches deep (this being all that the outfall would allow), and the lands laid flat. The rotation now adopted is—

"1st year. *Rape.*—Drilled on the flat 24 inches apart; manured with 2 cwt. of Peruvian guano, sown broadcast, and 24 bushels of Hull ashes.
"2nd year. *Wheat.*—9 inches apart; 8 pecks of seed per acre.
"3rd year. *Seeds.*—21 st. white clover, perennial parsley, trefoil.
"4th year. *Oats.*—9 inches apart; 12 pecks of seed per acre.
"5th year. *Beans.*—Drilled 24 inches apart, on the flat, manured with 10 tons of fold-yard manure per acre.
"6th year. *Wheat.*—As before.

"The above is the usual mode of cropping my farm. Changes are occasionally resorted to: such as on the 1st portion, peas or tares; and on the 2nd, beans or rape, instead of seeds; and sometimes wheat sown after early turnips, and oats after seeds.

"*Mode of Cultivating.*

"Having described the rotation, I shall now mention the method of managing the different crops on the 2nd portion of my farm, as that contains the most land, and the cultivation of them differs but slightly from those of the other portions.

"*Turnips.*—When the wheat-stubbles are cleared of their corn they receive a shallow ploughing (beginning with that part where swedes are to be grown), and are harrowed and cleaned, as far as weather will permit. The land then receives its winter ploughing. It is the custom of this neighbourhood not to plough deeper than 4 inches, however good the soil. I have, however, ventured to break through this custom; and having ascertained by digging holes the depth of good soil, have put the plough in an inch deeper, and have not yet had cause to repent of my practice. About 100 acres have already been treated in this way. The land is cross-ploughed as early in spring as possible, and worked with drag and common harrows, and commonly gets no other ploughing until seed-time. The first crop of couch is led home to the compost-yard, the rest burned. About the last week in May, or first week in June, swede-sowing begins. The land is then formed into ridges 26 inches apart, single-horse carts depositing fold-yard manure at the rate of 8 tons per acre, with 1 cwt. of Peruvian guano, which is sprinkled on the manure whilst the carts are loading. Women follow to distribute the manure evenly in rows (when properly done it looks like a continuous flat rope), and it is immediately covered in by the ploughs; then rolled, and the seed (2¼ lbs. of swedes, 2 lbs. of hybrids, and 2 lbs. of white per acre) deposited by Hornsby's two-rowed double-spouted drill, together with 24 bushels of Hull ashes per acre (N.B. This Hull ash is collected from privies, containing night-soil, entrails of fish, &c.), and again rolled. Soon after the turnips come up they are horse-hoed; then singled out, the swedes and hybrids with 9-inch, the whites with 8-inch hoes; and the horse-hoes kept constantly working among them as long as practicable.

"About the end of November one-half the swedes and hybrids, if the crop be good, are taken up, topped, tailed, and led home, to be stored in long heaps, of a wedge form, and well covered with straw, for the use of the fold-yards. The remainder are topped, tailed, and put into heaps

of 2 or 3 tons each in the field, and covered with soil, where they remain till spring, to be consumed on the land by sheep. The tops are led home to be eaten by store-cattle.

"When swede-sowing is finished that of hybrids begins. About 10 acres of early whites are sown in the beginning of June, in the same manner as that above described, except that no guano is applied. One-third is pulled off for fold-yard use, the rest eaten on the land by wether and gimmer hogs: the former receiving ½ lb. of oil-cake each per day, and all of them salt, and 1 sack a-day of cut hay to 200 sheep.

"The rest of the white turnips are sown on the flat with Hornsby's 3-rowed drill 24 inches apart, with 12 bushels bones and 24 Hull ashes, or 2 cwt. of Peruvian guano sown broadcast, and the drill following to deposit the seed. Garrett's horse-hoe is constantly used; one-fifth, if the crop be good, is led off for cattle; the rest consumed on the land by sheep. Last summer, instead of guano or bones, I used superphosphate of lime: thus, 4 bushels of bones dissolved in 80 lbs. of sulph. acid, together with 24 bushels Hull ash, were used for swedes; and 5 bushels bones to 100 lbs. acid (with Hull ash) for white turnips.

"It answered very well for whites *sown on the flat*, and for swedes. The early whites and hybrids came up very regularly, and were ready for the hoe a week sooner than usual, but, being sown on the ridge, were subsequently destroyed by the drought. I may mention a striking instance of the advantage in a dry season of drilling on the flat. Two fields, adjoining each other, with soils precisely similar, were drilled on the same day last year with white turnips. One was *ridged*, and manured with 9 tons fold-yard manure, 4 bushels bones and acid, 24 bushels Hull ashes: the other *drilled on the flat*, with 4 bushels bones and acid and 24 bushels Hull ashes. The latter was an excellent full crop; of the former one-half never came up at all, and the remainder was very bad. It has not been my practice to weigh turnips, except on one or two occasions, to ascertain the relative value of certain varieties, or of manures, &c. In 1840 one part of a field was sown with Skirving's swedes, the other part with Matson's swedes. The whole was treated alike, with 10 tons of yard muck, 24 bushels Hull ashes. In December an acre of each was topped, tailed, and weighed. Matson's weighed 25 tons, and Skirving's 30 tons per acre. This was the best and most even crop I ever grew.

"*Barley.*—Where swedes or hybrids have been grown, the land is ploughed across the ridges, harrowed and drilled with chevalier barley, from the first to the third week in April, at the rate of 10 pecks per acre, at 9 inches apart. If anything should delay the sowing beyond that time, 12 pecks per acre are sown.

"*Oats.*—Where white turnips have been grown and eaten off before Christmas, the land is half-ploughed or ridged, that it may lie warmer during winter. In March it is cross-ploughed, &c., with 12 pecks of seed per acre. The later eaten-off turnip-land receives but one ploughing; all the land, if possible, clod-crushed, and again, when the corn is up, rolled, &c.

"Last year I tried some experiments as to thin-sowing oats. A field was selected containing 17½ acres of rich loam on gravel in good

condition. In the autumn 1845 it had been ploughed 5 inches deep, viz. 1 inch deeper than ever before. In June, 1846, it was sown with yellow bullock turnips, well manured with fold-yard manure, &c. They were scarcely an average crop. One-third led off home; the rest eaten by sheep, with ½ lb. of oil-cake each per day, &c.

"On the 4th and 5th of March, 1847, oats were sown in the following way:—

| Expt. | Acres. | | |
|---|---|---|---|
| 1 | 2 | Red Oats from Mr. Hewit Davies, drilled at 13 inches apart, | 6 pecks per acre. |
| 2 | 2 | do. do. do. . . | 8 ,, ,, |
| 3 | 2 | Sovereign Oats, Mr. Watson Waudby | 8 ,, ,, |
| 4 | 6 | Red Oats, Davies . . . . . . | 8 ,, ,, |
| 5 | 5½ | Red Oats, ,, 9 inches apart . . | 12 ,, ,, |

"All the oats came up well, were rolled with a smooth roller, hand-hoed, and sown with seeds. They were a splendid-looking crop, and no one could say which part would turn out the best; a very small portion was laid, and that chiefly on the thicker sown part. The sovereign oats were longest in the straw, and ripe a few days earlier; they were all harvested the third week in August. I regret that I cannot give the result of the whole experiment, for they have not yet been all threshed; as far, however, as we have been able to ascertain, it is as follows:—

"1 acre of Experiment No. 5, viz. red oats, Davies, &c., yielded 89 bushels marketable corn.

"2 acres of Experiment 3, viz. sovereign, Watson, &c., yielded 238 bushels, or 119 bushels per acre.

"4 acres, viz. Experiments 1 and 2, red oats, H. Davies, yielded 91 bushels per acre.

"N.B. The quality of the red oats was good; that of the sovereigns moderate.*

"*Seeds.*—The quantity of seed per acre, and the method of sowing, have been already described, as well as the manuring which they receive after the corn (oats or barley) has been harvested. Sheep and lambs summer-eat the seed pasture. Early in the autumn 32 bushels of lime per acre are spread upon them, on a damp day or early dewy morning, for the purpose of destroying slugs; the land is then ploughed and pressed preparatory to wheat-sowing.

"*Wheat.*—The land is allowed to lie as long as possible after being ploughed, to gain solidity; then it is harrowed, and the seed, after being steeped in chamber-ley and arsenic (1 oz. of the latter per bushel), and dried with quick-lime, is drilled at 10 pecks per acre on the wold, and 8 pecks per acre on the rest of the farm. If sown after the end of November, 1 or 2 pecks are added per acre. As soon as sown, the land is rolled, except on strong soils, with Crosskill's 1½-ton weight crusher,

* Putting Experiment No. 3 out of the question, in which the enormous produce may be somewhat qualified by the inferiority of the sample, yet the success of Experiments Nos. 1 and 2 (at an average of 7 pecks of seed per acre) over that of No. 5 (averaging 12 pecks of seed per acre) merits a repetition of these experiments in the present year.

and again in spring. The thin sowing of wheat has been partially tried on this farm; but hitherto not with the success anticipated. In the autumn of 1845 some fields were sown with 6 pecks per acre; one field thus treated, of good loam on gravel, produced 40 bushels per acre, weighing 65 lbs. per bushel; another field of sandy loam yielded 39 bushels per acre, weighing $64\frac{1}{2}$ lbs. per bushel; another field, loamy gravel and loam on sand, produced only 24 bushels per acre, of inferior quality. In 1846, on good sandy loam, 4 pecks per acre of Australian white wheat were drilled at 11 inches apart. On the same day, in the same field, 6 pecks per acre of Spalding's prolific red, at 9 inches. All through the winter, spring, and summer the thinnest sown looked the best; this continued up to harvest; but, to my astonishment, on threshing, the thinnest sown, viz. 4 pecks, yielded only 25 bushels per acre; the thicker sown, viz. 6 pecks, yielded 34 bushels per acre. I am quite at a loss to account for this optical delusion, neither being laid nor shaken out by the wind.

"None of my thin-sown wheat has suffered from mildew to any extent, whereas wheat sown after turnips on the 8th and 9th of March, 1847, with 10 pecks of Hopetoun per acre, was spoiled by mildew.

"*Beans.*—Until lately beans have been sown in spring on wheat or oat stubble, manured with 10 tons of yard manure, ploughed in February; the beans drilled on the flat, 26 inches apart, 8 pecks per acre, and repeatedly hoed with horse and hand hoes.

Having, however, in the summer of 1846 seen some splendid crops of the Russian or winter beans on the farms of Mr. Hewit Davies, in Surrey, at a time when all the spring-sown beans in the country were looking wretchedly, I was induced to give them a trial: and on the 3rd of October, 1846, after cleaning and manuring with 8 tons of yard manure per acre, in a field of sandy loam (one of the weakest and worst on my farm), I drilled the beans (8 pecks per acre) on the flat, at the same distance apart as usual. They did not suffer in the least from the very severe winter of 1846–7; the only fault was being too thick, which caused the crop to be less productive. We began to reap them on the 5th of August, being the same day that my wheat harvest commenced. I have continued the practice, but sown less seed, viz. 6 and 7 pecks per acre.

"*Grass Land.*—About 70 acres are annually mown for hay; the same fields being meadowed every year, and manured every other year with 10 tons per acre. The remaining 230 acres are depastured with cattle and sheep. All the cattle-droppings are gathered by old men and boys with wheelbarrows and shovels, put into heaps, and covered with soil every evening (old banks, road-scrapings, &c., are used for this purpose), and in frost laid on the poorest parts of the fields at the rate of 5 tons per acre. It is found that a larger quantity than this is apt to render the herbage so rank that the cattle avoid it during the whole of the succeeding summer. This system has been found most beneficial. The fields present a much more even pasturage than they used to do, and even under hedges and trees are as palatable to the cattle as on any other part.

"*Live Stock.*—The live stock kept on the farm consists of 20 active

horses; 6 Devon working oxen; from 120 to 130 short-horned cattle; 100 pigs of different ages, and 1000 Leicester sheep.

"The horses are fed on cut hay, with 2 bushels of oats per week each, from the beginning of October to the beginning of June. In summer they get green meat with oats, according to their work, and are put into the fold-yard at night, but are never turned out to grass. The cattle are chiefly bred, reared, and fattened on the farm. Such of the pigs as are not wanted for bacon are sold as store pigs.

"*Sheep.*—My flock consists of 450 breeding ewes (well-bred Leicesters), which receive the ram about the middle of October; those of two shear and upwards are put upon rape 10 days previously, and are served in stocks. This is done not only with a view of obtaining more lambs, but it is found that according to this way a ram will serve 120 ewes with as much ease as he would 80 if he were running loose. With the shearlings a different system is pursued, it being desirable that they shall produce only one lamb apiece; they are put on good pasture all summer, and the rams turned loose with them on new seeds or fresh pasture. All the ewes are kept on grass in the winter, except in the case of deep snow, when a little hay is given. In the beginning of February they are put on turnips, where they remain until lambing-time. A well-sheltered yard, with a permanent lambing-shed attached, is prepared for them; into this yard all the ewes likely to lamb are brought every evening, and are served with hay. As soon as they lamb they are put on dry grass land, with cabbages, oil-cake, &c., and are moved on to 1-year seeds as the lambs get stronger. About the middle of July the lambs are weaned, and are put on grass land where *no sheep have been depastured the same season.* In September the lambs are put on rape, or early white turnips, when they receive, as I have said, ½ lb. of oil-cake each, cut hay, &c. The gimmers follow them; get the same allowance of hay, but no oil-cake. All the sheep, except ewes when near lambing, have rock-salt given them in covered troughs in winter, and in large lumps laid in the fields in summer. The wether hogs are sold to the butcher when about 13 months old, averaging about 22 lbs. per quarter.

"*Fences.*—When the farm first came into my hands the fences were very bad, and it has been a tedious as well as an expensive matter to get them into order. Those around the arable fields are all kept on the wedge plan, 5 feet high, and 4 feet broad at the base. They are cut every winter with a one-handed slasher. When a hedge has through neglect become open at bottom, it is cut to the ground, healthy stems being left near the gaps; these stems are carefully cut, but not through, and laid upon the ground, and pegged down: the soil on each side of the hedge is dug for 3 feet wide, and kept clean, and the layers send up strong upright shoots. The following spring the layers are covered with soil, and the hedge all grows up together.

"*Draining.*—Upwards of 200 acres have been under-drained within the last few years, at various depths and distances, according to circumstances, and in cases up to 1847 with tiles and flats; in that year some land was drained with pipes, 2 inches in diameter, having a flattened

bottom. In many cases the draining at 24 to 30 inches deep was found, where there were springs, to be quite ineffectual, and has been done over again at 4 to 6 feet deep, and 20 yards apart: wooden spouts 3 feet long are fitted to the ends of the outlets, to prevent their being damaged by frost, as also by men's spades in cleaning the ditches.

"*Manure.*—Every exertion is made to produce and collect as much good manure upon the farm as possible. All the fold-yards are made hollow in the centre, and the bottoms water-tight, and the buildings are spouted: the principal yards have tanks to receive the liquid manure. There is one, likewise, near the slaughter-house, which receives the blood and entrails of about 10 porkers, 16 bacon-hogs, and 50 sheep, as well as dead calves, lambs, pigs, &c. Near to this is a compost-yard, in which road-scrapings, scourings of ditches, couch, &c., are collected. Whenever opportunity offers, and from time to time, the contents of the liquid-manure and slaughter-house tanks are mixed with the heap, which is occasionally turned over, and forms an excellent top-dressing for grass-land. The manure intended for swedes or hybrids is led out of the fold-yards after Christmas (direct to the field, if at a distance), and built up into a heap 12 feet high, and as compact as possible, in a large hollow yard, with a tank and pump in the centre; the contents of which are occasionally pumped over the heap, which is never turned. The manure for seeds, meadows, &c., is led out after the cattle have left the yards, and is treated in the same manner."

## VI.—*Analyses of the Ashes of Plants.* Third Report. By J. Thomas Way and George Ogston.

Various circumstances, which it is quite unnecessary to particularise in this place, prevented us from presenting our Third Report on Plant-ashes in the last Journal. To one of these causes of delay we are, however, anxious to draw particular attention. Early in the year 1847 the eminent chemist Professor Rose, of Berlin, published a paper in a German scientific periodical, the intention of which was to show that all previous analyses of the ashes of vegetable and animal substances were open to doubt, not on account of alleged incorrectness in the methods of analysing these ashes, but rather because the method of *preparing* the ashes for analysis was itself faulty and liable to objection. In other words, Professor Rose endeavoured to show that the ashes of a plant do not actually represent its mineral matter; that, in fact, in burning a vegetable or animal substance we dissipate not only the organic portion—the carbon, hydrogen, oxygen, and nitrogen—but also a variable though essential amount of the mineral matters.

A notice on this subject appeared about the same time from the pen of Professor Mitscherlich, another Continental chemist of high repute. The evidence adduced by Professor Mitscherlich was similar in character to that brought forward by Rose, and tended to the same result, namely, that the usual methods of burning preparatory to the analysis of ashes did not afford correct results. Both these chemists proposed for future adoption particular methods of combustion to obviate the errors which they had then pointed out, and insisted upon the necessity of pursuing amended plans in all analyses of ashes intended to be used in the deduction of scientific principles, either in vegetable or animal physiology.*

The publication of these results, together with a feeling existing in the minds of English chemists, of the unsatisfactory nature of the evidence on the whole subject, left us, in our opinion, no alternative but to institute a rigorous examination both of the methods of preparing and of analysing plant-ashes. We felt that it was due to the Society who have intrusted this subject to our care, previously to the publication of any further results, to ascertain by careful experiment how far the ash of a plant, prepared as we are in the habit of preparing it, really represents the actual mineral matter of the vegetable product under examination.

The decision of this point has, as every chemist will understand, only been accomplished after the expenditure of very much labour and time, but it has resulted in the conviction of our own minds that, *with one exception,* the ordinary methods of burning, when carefully conducted, give ashes which, not only for all practical purposes, but for scientific deduction, may be taken to represent accurately the mineral composition of vegetable substances in general.

The single exception (and it is certainly a most important one) is that of sulphur. No system of ordinary burning, however slowly or carefully conducted, is capable of giving the true quantity of sulphur, or, indeed, any approximation to the true quantity, in vegetable substances submitted to examination.†

In this respect all the analyses hitherto published are, in common with our own, open to objection; but it is satisfactory to

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* We may mention by the way, although with every deference for the judgment of the great authorities in question, that both of the methods proposed were far too operose, involved too much time and labour, to be at all applicable to the necessities of an investigation so extended as that of plant-ashes must necessarily prove; neither, as we hope to show, do these plans ensure a greater amount of accuracy than is obtainable by very slight modifications of the ordinary processes.

† Rose's method even is defective in this respect.

know in future how to avoid this error, and as we have retained specimens we shall, by a very little trouble, be enabled to introduce a correction for this substance in all the important analyses that have been published in our previous reports.*

In order that those who are conversant with the processes of analytical chemistry may feel full confidence in the results of our inquiries, we insert in an appendix an account of some of the more important experiments.

The analyses which follow comprehend specimens of sainfoin, Italian rye-grass, and red and white clover, three specimens of the flower of the hop, and a series of beans and peas grown on different soils.

We give, first, the analysis of a specimen of white and another of red clover grown on clay, and of the same plants grown on silicious sand.

The specimens were received from Mr. J. C. Morton, of Whitfield. The soils upon which they were grown are on one of the beds of the *Silurian* series. In 1843 the land was drained and broken up from old grass—in 1844 the crop was oats—in 1845 mangold-wurzel (well manured with horse-dung)—1846, wheat 32 bushels to the acre—in 1847 the clover.

The specimens of clover were dried in the air until they attained the condition of ordinary new-made hay; in this state they still retained a considerable portion of water, as is seen in the following table:—

Percentage of Water and Ash in four specimens of Clover Hay.

| | Red Clover. | | White Clover. | |
|---|---|---|---|---|
| | Silicious Sand. | Clay. | Silicious Sand. | Clay. |
| Water | 13·97 | 12·20 | 12·60 | 12·00 |
| Ash | 6·77 | 7·12 | 7·70 | 7·61 |
| Ash calculated on the dry | 7·87 | 8·11 | 8·81 | 8·65 |

The next table exhibits the composition of these several ashes, to which is added the *mean* composition of the two varieties.

* If it be necessary to plead any extenuation of an omission of which all previous ash analysts have been guilty, we may refer to a high authority, Boussingault, who distinctly states, as the result of experiment, that sulphur is *not* lost in the combustion of plants.—*Boussingault*, French edit., vol. ii. p. 231.

Composition in 100 parts of the Ash of Red and White Clover Hay.

| | Red Clover. | | White Clover. | | Mean of the Analyses. | |
|---|---|---|---|---|---|---|
| | Silicious Sand. | Clay. | Silicious Sand. | Clay. | Red Clover. | White Clover. |
| Silica . . . . . | 4·03 | 2·66 | 4·63 | 2·74 | 3·34 | 3·68 |
| Phosphoric Acid . . | 5·82 | 6·88 | 10·93 | 12·12 | 6·35 | 11·53 |
| Sulphuric Acid . . | 3·91 | 4·46 | 7·05 | 7·38 | 4 18 | 7·21 |
| Carbonic Acid . . | 12·92 | 20·94 | 18·64 | 17·41 | 16·93 | 18·03 |
| Lime . . . . . | 35·02 | 35·76 | 26·32 | 26·51 | 35·39 | 26·41 |
| Magnesia . . . | 11·91 | 10·53 | 7·46 | 8·83 | 11·22 | 8·15 |
| Peroxide of Iron . . | 0·98 | 0·95 | 1·17 | 2·76 | 0·97 | 1·96 |
| Potash . . . . . | 18·44 | 11·30 | 15·17 | 13·50 | 14·85 | 14·33 |
| Soda . . . . . . | 2·79 | .. | 3·03 | 4·41 | 1·40 | 3·72 |
| Chloride of Sodium . | 4·13 | 0·58 | 5·56 | 4·32 | 2·36 | 4·94 |
| Chloride of Potassium | .. | 5·92 | .. | .. | 2·96 | .. |
| Total . . . | 99·95 | 99·98 | 99·96 | 99·98 | 99·95 | 99·96 |

It is impossible, in carefully examining this table, not to observe how very little difference really exists between the specimens of the same variety grown upon different soils: the numbers given for red clover on sand and clay are, in most respects, singularly alike; and the same of the two columns for the white clover.

In the red clover it will be seen that some difference occurs in the proportion of carbonic acid and in that of potash. The first of these discrepancies is of little importance; for (as we have pointed out in an appendix to this paper) it is impossible to ensure coincident results, in respect to carbonic acid, in the burning of plants for analysis. The relation between the two numbers given for potash would be much nearer if the proportion considered as chloride of potassium were taken into account.

The two specimens of white clover give results still more resembling each other, although differing considerably from those of red clover.

It would not be by any means safe to draw very decided conclusions from one or two analyses of this kind, but, so far as an opinion may be formed, the evidence would tend to prove that the *mineral* constitution of clover is but little affected by the character of the soil on which it grows—whilst, on the other hand, the different varieties of the plant are found to possess a mineral constitution in some respects essentially distinct.

The proportion of sulphuric acid given in the ash does not, as we have already mentioned, truly represent the total sulphur of the plant. When estimated by the method mentioned in the appendix, the sulphur in these specimens was found to be as follows :—

Total Amount of Sulphur in 1000 parts of Clover.

| | Red Clover. | | White Clover. | |
|---|---|---|---|---|
| | Silicious Sand. | Clay. | Silicious Sand. | Clay. |
| Sulphur in 1000 parts of clover-hay . . | 3·527 | 4·741 | 3·411 | 3·080 |
| Sulphur in 1000 parts of the dry substance | 4·099 | 5·399 | 3·902 | 3·500 |

In comparison with the last numbers of the actual sulphur in the dry clover, we give the proportion of sulphur as found in the *ash* of 1000 parts of the plants calculated from the foregoing analysis:—

| | Red Clover. | | White Clover. | |
|---|---|---|---|---|
| | On Sand. | On Clay. | On Sand. | On Clay. |
| Sulphur *in the ash* of 1000 parts of dry clover | 1·206 | 1·452 | 2·492 | 2·561 |

It will be seen that, in the case of the red clover, fully two-thirds of the whole sulphur is dissipated in the combustion, and we conclude* that *at least* this proportion must have existed in the plant in some other condition than as sulphuric acid. With the purpose of exhibiting the extent of *mineral exhaustion* due to a clover-crop, we have drawn up a table of the amount of the various substances in a ton of red and white clover-hay. The average of the two analyses is taken in each case, and for the sake of uniformity the calculations are upon specimens containing 12 per cent. of water.

The carbonic acid of the ash is omitted.

Mineral Matters in a ton of Red and White Clover Hay, in lbs. and tenths.

| | Red Clover. | White Clover. |
|---|---|---|
| | lbs. | lbs. |
| Silica . . . . . | 5·2 | 6·3 |
| Phosphoric Acid . . | 10·0 | 19·9 |
| Sulphuric Acid . . | 6·6 | 12·4 |
| Lime . . . . . | 55·6 | 45·5 |
| Magnesia . . . | 17·7 | 14·0 |
| Peroxide of Iron . . | 1·5 | 3·4 |
| Potash . . . . . | 23·2 | 24·7 |
| Soda . . . . . | 2·2 | 6·4 |
| Chloride of Sodium . | 3·7 | 8·5 |
| Chloride of Potassium | 4·7 | .. |
| Total . . . | 128·4 | 141·1 |

* For the arguments on this subject see Appendix.

The total sulphur removed in a ton of hay, and the quantity of sulphuric acid to which it is equal, are as follows:—

| | | |
|---|---|---|
| Red Clover . | . 7·3 lbs. = 18·2 lbs.* | sulphuric acid. |
| White Clover | . 9·3 lbs. = 23·2 „ | „ |

It will be asked, do the foregoing analyses throw any light upon the cultivation or peculiarities of clover?

Of course any observations that can be made here have reference only to the mineral matters of the plant, and are therefore in no way to be considered as comprehending the whole question. Taken *solely* in reference to its mineral composition, we should be induced to call clover an exhausting crop—that is, when the produce is removed in the state of hay. A fair crop of red or white clover would, indeed, with the exception of silica, carry off fully as much of the mineral wealth of the soil as an average crop of wheat or barley; but there is, it is conceived, nothing in the analyses of the clover here given that would justify us in attributing the difficulty of its cultivation to any peculiarity in *mineral* constitution. It was hoped that the analyses might throw some light upon the use of gypsum to the clovers, although, amongst practical men, it is still a subject upon which very conflicting opinions are entertained. Granting, for the sake of argument, that gypsum is beneficial to clover, is its action referrible, as Boussingault maintains, to the *lime* of the compound? Does it benefit the plant by the sulphuric acid or sulphur it supplies? or lastly, are we to believe, with Liebig, that it is simply as a vehicle for the collection and presentation to the plant of ammonia that we are to regard this substance when employed as a top-dressing to clover?

The only one of these theories which the results we have presented will allow us to speculate upon is that of the supply through gypsum of sulphur and sulphuric acid.

At first sight we might be disposed to attribute some considerable share of this effect to the cause mentioned. A ton of white clover-hay contains, in one form or another, 9·3 lbs. of sulphur, which, in the absence of any proof that compounds of sulphur are derived by vegetation from the air, we must believe to have been supplied by the soil.

9·3 lbs. of sulphur are contained in about 23·2 lbs. of sulphuric acid, which quantity would be furnished by 50 lbs. of pure gypsum, or, in round numbers, by ½ cwt. of the common commercial article. This is certainly a large quantity; and it might be doubted whether, in all cases, the natural supply of sulphuric acid in the soil would be adequate to meet the demand; but we shall have occasion to show that many crops, to which no one would think of applying gypsum, do in reality carry off far more

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* *Dry* sulphuric acid ($SO_3$).

sulphur than clover; and although we have no intention of denying the use of gypsum in the cultivation of clover (a point upon which we do not feel qualified to form an opinion), we would suggest that it must act in some other way than as a simple supply of sulphur or sulphuric acid to the crop.

*Sainfoin.*—Analyses have been made of the ashes of sainfoin. It was thought advisable to examine this plant in the state in which it is usually cut for hay and at a later period of its growth.

The specimens described were furnished by Mr. Robert Raynbird, of Hengrave, Bury St. Edmunds: they were grown on a light gravelly loam, with a subsoil of gravel above chalky clay. The two previous crops were swedes (fed off) and barley. The sainfoin followed the barley, being grown for one year in lieu of clover. The seed was drilled and harrowed in on the 22nd of April, 1846, after the barley had vegetated.

Specimen No. 1 was taken when *in flower,* June 5th, 1847.

Specimen No. 2, a portion of the same crop, taken when *the seed was ripe,* July 12th, 1847. Care was taken to preserve the seed, which was subsequently burnt with the rest of the plant. The specimens were allowed to dry naturally in the air, but, like all other vegetable substances, they still retained a certain proportion of water, as the following table shows:—

Water and Ash of Sainfoin in Flower and in Seed.

| | In flower. | | In seed. |
|---|---|---|---|
| Water . . . . . . . . . . | 11·24 | .. | 12·34 |
| Ash . . . . . . . . . . . | 5·65 | .. | 5·70 |
| Ash calculated on the dry substance | 6·37 | .. | 6·50 |

The analysis of the ash gives the following results:—

Composition of the Ash of Sainfoin in *Flower* and in *Seed;* with the Mineral Matters in a ton of each Specimen.

| | In 100 parts. | | Removed by a ton of each crop. | |
|---|---|---|---|---|
| | No. 1. Specimen in flower. | No. 2. Specimen in seed. | No. 1. Specimen in flower. | No. 2. Specimen in seed. |
| | | | lbs. | lbs. |
| Silica . . . . | 3·22 | 3·49 | 4·5 | 5·0 |
| Phosphoric Acid . . | 9·35 | 7·97 | 13·2 | 11·5 |
| Sulphuric Acid . . | 3·28 | 2·33 | 4·6 | 3·4 |
| Carbonic Acid . . | 15·20 | 17·36 | .. | .. |
| Lime . . . . | 24·30 | 29·67 | 34·3 | 42·9 |
| Magnesia . . . | 5·03 | 4·59 | 7·1 | 6·4 |
| Peroxide of Iron . . | 0·61 | 0·58 | 0·9 | 0·8 |
| Potash . . . . | 31·90 | 29·61 | 45·1 | 42·8 |
| Soda . . . . . | .. | 1·25 | .. | 1·8 |
| Chloride of Sodium . | 0·78 | 3·12 | 1·1 | 4·5 |
| Chloride of Potassium | 6·24 | .. | 8·8 | .. |
| Total . . . | 99·96 | 99·97 | 119·6 | 119·1 |

The *total* sulphur in 1000 parts of these specimens is as follows:—

| | Specimen in flower. | | Specimen in seed. |
|---|---|---|---|
| Sulphur in 1000 parts dried in the air . . | 0·497 | .. | 0·552 |
| Do. in the dry substance . . . . . . . . | 0·560 | .. | 0·630 |

No particular remarks occur to us in reference to these analyses. In many respects the ash of sainfoin resembles that of clover; but the quantity of it in a given weight of crop is less than in the last-named plant.

The columns of mineral matters in a ton of the specimen are given, because, as we have elsewhere remarked, this relation is the really important point in ash analysis.

The results exhibited by the 3rd and 4th columns of this table are interesting, as showing how little influence comparatively can be ascribed to the seeding of such a plant as this in the mineral exhaustion of the soil. It is well known that seeds are rich in phosphoric acids; and we might expect that the ash of a plant, including the seeds, would exhibit a larger proportion of this acid than that of the same plant in flower. It would seem, however, that, in proportion to the whole bulk of the plant, the seeds are, in this case, insignificant in quantity, and their effects upon the composition of the ash inappreciable.

These remarks, of course, do not apply to plants that are cultivated for their seeds—which, forming a large proportion of the whole plant, must be necessarily exhausting to the soil—neither do they apply to the general question of exhaustion by seeding, but only to that involving mineral matters; so far also as the seeded crop is greater in absolute weight than before this period, so will it also remove a larger amount of mineral matters from the soil.

The following are analyses of Italian rye-grass in flower and seeded:—

This crop was also grown by Mr. Robert Raynbird; the soil, a gravelly loam, tolerably rich in vegetable matter; crop of 1846 was barley. The rye-grass was drilled on the 5th of May, at the rate of 2 pecks with 1 peck of clover per acre. The clover failed, leaving a good plant of rye-grass.

The specimen in flower was gathered June 5th, 1847; that in seed, on the 12th of July, 1847. The seed was burnt with the rest of the plant.

The specimens were both of them in the state of *natural* dryness; the water and ash were as follows:—

Water and Ash in specimens of Italian Rye-grass.

| | In flower. | | Seeded. |
|---|---|---|---|
| Water . . . . . . . . . . . | 11·59 | .. | 13·10 |
| Ash . . . . . . . . . . . | 6·16 | .. | 5·56 |
| Do. calculated on the dry substance | 6·97 | .. | 6·40 |

The following are the results of the analyses:—

Analyses of the Ash of Specimens of Italian Rye-grass, cut when in Flower and in Seed.

| | | | In a ton of the Specimens. | |
|---|---|---|---|---|
| | In flower. | In seed. | In flower. | In seed. |
| Silica | 59·18 | 60·62 | 81·7 | 75·5 |
| Phosphoric Acid | 6·34 | 6·32 | 8·8 | 7·8 |
| Sulphuric Acid | 2·82 | 1·31 | 3·9 | 1·6 |
| Carbonic Acid | .. | .. | .. | .. |
| Lime | 9·95 | 12·29 | 13·8 | 15·3 |
| Magnesia | 2·23 | 2·64 | 3·1 | 3·3 |
| Peroxide of Iron | 0·78 | 0·30 | 1·1 | 0·4 |
| Potash | 12·45 | 10·77 | 17·2 | 13·4 |
| Soda | 3·98 | 0·13 | 5·5 | 0·2 |
| Chloride of Sodium | 2·27 | 5·58 | 3·1 | 6·9 |
| Chloride of Potassium | .. | .. | .. | .. |
| Total | 100·00 | 99·96 | 138·2 | 124·4 |

The *total* sulphur in these specimens, in 1000 parts, is as follows:—

| | Specimen in flower. | | Specimen in seed. |
|---|---|---|---|
| Sulphur in the undried specimens | 0·601 | .. | 0·347 |
| Sulphur in the dry | 0·680 | .. | 0·401 |

The same remarks will apply to these analyses as to those of sainfoin. The composition of the ash is evidently but little altered by the presence of the seed, probably because it is small in quantity.

It is seen that Italian rye-grass is, like other cereals, a *silicious* plant, and, indeed, in the quantity of silica which it removes from the soil it surpasses even wheat-straw, which, it will be remembered, contains about 60 lbs. in every ton weight.

Where, therefore, the use of liquid manure is able to produce many successive luxuriant crops of this plant, there can be no want of available silica in the soil for any crops.

*Hops.*—The following are analyses of three specimens of the flower of hops:—

*Specimen* No. 1.—Bentley hops grown by Mr. Samuel Eggar on a deep rich soil resting on the grey marl rock; manured in 1847 with farm manure and woollen rags. The hops were gathered in the second week of September, 1847. Produce 5 cwt. per acre.

*Specimen* No. 2.—Golding hops from Mr. J. M. Paine of Farnham. This specimen was grown on land that has been in cultivation as hop-ground for more than 100 years, highly manured every year; the manure in 1847 was guano and woollen

rags. The crop, which had suffered from the aphis blight, was 8 cwt. per acre, gathered in the last week of September.

*Specimen* No. 3.—A small variety of the Grape-hop from the same district. The subsoil is the soft lower marl. The field has been fifteen years in plant, being manured in alternate years with dung and artificial manures, such as guano, rags, &c. The specimen was gathered at the same time as the last. Crop 10 cwt. per acre.*

The hops, when taken for examination, were in the ordinary condition as dried for bagging. In the drying of Nos. 2 and 3 sulphur was employed, but not in that of No. 1. It is necessary to mention this circumstance in reference to the differences which will be observed in their composition.†

The water and ash in the specimens of hops were as follows:—

| | No. 1. Bentley. | | No. 2. Golding. | | No. 3. Grape. |
|---|---|---|---|---|---|
| Water . . . . . . . . . . . | 9·91 | .. | 12·33 | .. | 9·66 |
| Ash . . . . . . . . . . . . | 7·27 | .. | 5·22 | .. | 6·52 |
| Do. calculated on the dry substance . | 8·07 | .. | 5·95 | .. | 7·21 |

The following table gives the analyses of these three specimens of hops:—

Composition of three Specimens of the Ash of the Flower of Hops.

| | No. 1. Bentley. | No 2. Golding. | No. 3. Grape. | Mean of three Specimens. | Mean analysis, in a ton of Hops. |
|---|---|---|---|---|---|
| | | | | | lbs. |
| Silica . . . . . . | 22·97 | 19·71 | 9·99 | 17·56 | 25·0 |
| Phosphoric Acid . . | 21·38 | 14·47 | 17·58 | 17·81 | 25·2 |
| Sulphuric Acid . . | 7·01 | 7·27 | 11·68 | 8·65 | 12·3 |
| Carbonic Acid . . | 5·44 | 2·17 | 4·54 | 4·05 | .. |
| Lime . . . . . . | 17·93 | 21·59 | 18·47 | 19·33 | 27·5 |
| Magnesia . . . . | 5·94 | 4·69 | 5·27 | 5·30 | 7·5 |
| Peroxide of Iron . . | 1·86 | 1·75 | 1·41 | 1·67 | 2·4 |
| Potash . . . . . . | 11·98 | 24·88 | 25·56 | 20·81 | 29·5 |
| Soda . . . . . . | .. | .. | .. | .. | .. |
| Chloride of Sodium . | .. | 3·42 | 41·02 | 1·48 | 2·1 |
| Chloride of Potassium | 5·45 | .. | 4·34 | 3·26 | 4·6 |
| Total . . . | 99·96 | 99·95 | 99·96 | 99·92 | 136·1 |

* For these analyses I am indebted to my friend and pupil, Mr. Frederick Eggar. They were made under my own constant superintendence, and I have perfect faith in the results—Mr. Eggar having qualified himself for such examinations by eight months' assiduous practice in this species of mineral analysis.—J. T. Way.

† It is well known to all who live in the hop districts that many hop-growers are in the habit of burning sulphur in the charcoal fires which they employ for drying the hops. The sulphur of course is converted into sulphurous acid, which, with the carbonic acid and heated air of the furnaces, passes through the stages upon which the hops are placed. This

The *total sulphur* in the hops was, in 1000 grains,—

| | No. 1. Bentley. | No. 2. Golding. | No. 3. Grape. |
|---|---|---|---|
| In the partially dried state | 3·50 | 4·11 | 4·70 |
| In the dry state . . . . | 3·90 | 4·72 | 5·20 |

But, as we have previously mentioned, the two latter specimens were "sulphured" in the drying, and there can be little doubt that, by oxidation at the time or subsequently, some of the sulphurous acid must have become fixed in the specimens. No stress is therefore laid upon the observed difference; the difference in the proportion of silica in these samples is peculiar. This circumstance is not, so far as we can discover, in any way accounted for by the history of the specimen, but it tends to prove that the discordant results of other analysts of the hop are not necessarily referrible to any errors on the part of the investigator, but are within the limits of deviation in the constitution of the plant.*

The following are analyses of peas and beans grown on different soils :—

With the view of ascertaining to what extent the mineral constitution of the crops in question would, under the ordinary system of culture, be affected by differences in soil, supplies of seed were forwarded by Messrs. Gibbs, of Half Moon-street, to several gentlemen who were kind enough to undertake the experiments. The varieties selected were, of peas—the Early White and the Prolific Maple; and of beans—the Heligoland, or Tick, and the Mazagan.

The only specimens which we have had time to examine are those from clay and silicious sand—the specimens on clay being grown by Mr. Druce, of Ensham, near Oxford; and those on sand by Mr. Morton, of Whitfield.†

The clay soil is a strong clay, imperfectly drained. The previous crop was clover. The crops were planted on the 6th of April, 1847, and harvested as follows: the early white peas on the 3rd, and the prolific peas on the 11th of August; the Maza-

practice of employing sulphur is by no means universal. Those who make use of it consider that it facilitates the drying of the hops, besides rendering the product of a better colour, and more acceptable to the brewers. To the chemist the practice offers several interesting topics of speculation, for which however this is no suitable place.

* Mr. Nesbit found 20 per cent. of silica in the hop. Professor Johnstone (Journal of Agriculture, July 1847) in a specimen of hops analysed in his laboratory only obtained 11 or 12 per cent. From the analyses given above it is plain that neither of these results is to be regarded as necessarily incorrect.

† We are indebted to Mr Pusey, Mr. Huxtable, and Mr. Arkell for similar specimens, which as yet we have been unable to examine.

gan beans on the 14th, and the Heligoland on the 31st of the same month.

The sandy soil is a silicious sand of the old red-sandstone; deep, but poor. The crops under discussion were taken after a fallow, and were sown between the 17th and 22nd of April, 1847. A portion of the seed was reserved and analysed, in order that the produce might be compared with it.

## Peas.

The first analyses are those of early white peas.

Percentage of Water and Ash in three Specimens of Early White Peas.

| | Water. | Ash. | Do. calculated on dry. |
|---|---|---|---|
| No. 1. The seed | 13·60 | 2·40 | 2·80 |
| No. 2. Produce on clay | 15·40 | 2·38 | 2·77 |
| No. 3. Produce on silicious sand | 13·60 | 2·48 | 2·87 |

The composition of the ash was as follows:—

Composition in 100 parts of the Ash of Early White Peas.

| | No. 1. The Seed. | No. 2. Produce on Clay. | No. 3. Produce on Silicious Sand. | Mean. |
|---|---|---|---|---|
| Silica | 1·76 | 1·12 | 1·55 | 1·48 |
| Phosphoric Acid | 38·05 | 37·93 | 35·66 | 37·21 |
| Sulphuric Acid | 6·70 | 4·04 | 7·26 | 6·00 |
| Carbonic Acid | 0·98 | 1·16 | 1·95 | 1·36 |
| Lime | 6·16 | 7·03 | 6·41 | 6·53 |
| Magnesia | 7·03 | 7·33 | 6·61 | 6·99 |
| Peroxide of Iron | 0·64 | 0·76 | 1·21 | 0·87 |
| Potash | 35·43 | 40·40 | 39·22 | 38·37 |
| Soda | 0·44 | 0·21 | .. | 0·22 |
| Chloride of Sodium | 2·81 | .. | .. | 0·94 |
| Chloride of Potassium | .. | .. | .. | .. |
| Total | 100·00 | 99·98 | 99·97 | 99·97 |

The *total* sulphur in 1000 grains of the undried specimens was found to be—

| Seed. | Produce on Clay. | Produce on Sand. |
|---|---|---|
| 3·217 | 2·362 | 2·159 |

Percentage of Water and Ash in the Prolific Maple or Grey Peas.

| | Water. | Ash. | Ash on dry. |
|---|---|---|---|
| No. 1. Seed | 14·60 | 2·24 | 2·60 |
| No. 2. Produce on clay | 16·60 | 2·40 | 2·87 |
| No. 3. Produce on sand | 16·40 | 2·14 | 2·56 |

The composition of the ash of the grey peas is given in the next table.

Composition in 100 parts of the Ash of Prolific Maple or Grey Peas.

| | No. 1. Seed. | No. 2. Produce on Clay. | No. 3. Produce on Silicious Sand. | Mean. |
|---|---|---|---|---|
| Silica | 1·74 | 0·68 | 0·62 | 1·01 |
| Phosphoric Acid | 29·92 | 36·50 | 30·82 | 32·41 |
| Sulphuric Acid | 6·23 | 4·47 | 5·38 | 5·36 |
| Carbonic Acid | 4·38 | 0·82 | 1·60 | 2·27 |
| Lime | 5·73 | 4·78 | 7·81 | 6·11 |
| Magnesia | 5·92 | 5·78 | 6·77 | 6·16 |
| Peroxide of Iron | 0·44 | 0·18 | 0·30 | 0·31 |
| Potash | 42·43 | 41·70 | 42·00 | 42·01 |
| Soda | 3·27 | .. | .. | 1·09 |
| Chloride of Sodium | .. | 1·24 | .. | 0·41 |
| Chloride of Potassium | .. | 3·82 | 4·70 | 2·84 |
| Total | 99·96 | 99·97 | 100·00 | 99·98 |

Total Sulphur in 1000 grains of the Grey Peas undried.

| Seed. | | Produce on Clay. | | Produce on Sand. |
|---|---|---|---|---|
| 1·691 | .. | 2·183 | .. | 2·254 |

It will be seen that the ash of peas is principally composed of phosphoric acid and potash; these two substances forming nearly three-fourths of the whole mineral matter.

With respect to the influence of the soil upon the mineral constitution of these specimens, it is difficult to form any very decided opinions. If the first of these tables is inspected, it will be seen that very little differences exist between the seed and the produce on sand or clay. The second table exhibits a difference in the phosphoric acid of the clay specimen, but on the whole the deviations in this case are not strongly marked.

On the other hand, it would seem that a slight difference of composition is to be traced to the *variety*; for if a comparison is made of the *mean* composition of the ash of grey and white peas, it will be found that the percentage of phosphoric acid is lower, and of potash higher, in the former than in the latter specimens.

The straw of these specimens was also analysed, the pods being included.

Percentage of Water and Ash in four Specimens of the Straw of Peas.

| | Water. | | Ash. | | Ash on dry. |
|---|---|---|---|---|---|
| Straw of early white peas on clay . | 11·89 | .. | 6·71 | .. | 7·61 |
| ,, ,, sand . | 6·34 | .. | 7·03 | .. | 7·50 |
| Straw of grey peas on clay . . | 11·36 | .. | 5·79 | .. | 6·53 |
| ,, ,, sand . . | 8·66 | .. | 6·86 | .. | 7·50 |

Composition in 100 parts of the Ash of Pea-Straw, on Clay and on Sand.

| | Straw of White Peas. | | Straw of Grey Peas. | | Mean of the Specimens. | |
|---|---|---|---|---|---|---|
| | On Clay. | On Sand. | On Clay. | On Sand. | Straw of White Peas. | Straw of Grey Peas. |
| Silica . . . . . . | 6·67 | 5·48 | 3·23 | 6·10 | 6·07 | 4·66 |
| Phosphoric Acid . . | 5·38 | 3·78 | 4·65 | 4·18 | 4·58 | 4·42 |
| Sulphuric Acid . . | 8·62 | 4·13 | 8·69 | 1·22 | 6·38 | 4·95 |
| Carbonic Acid . . . | 9·46 | 18·72 | 12·48 | 18·28 | 14·09 | 15·38 |
| Lime . . . . . . | 38·61 | 39·72 | 37·17 | 36·47 | 39·16 | 35·82 |
| Magnesia . . . . | 8·27 | 4·25 | 7·17 | 7·22 | 6·26 | 7·20 |
| Peroxide of Iron . . | 1·57 | 2·63 | 1·07 | 1·80 | 2·10 | 1·43 |
| Potash . . . . . . | 13·22 | 17·50 | 21·30 | 16·63 | 15·36 | 18·97 |
| Soda . . . . . . | 0·95 | 0·86 | 4·22 | 3·90 | 0·91 | 4 06 |
| Chloride of Sodium . | 7·22 | 2·90 | .. | 4·16 | 5·06 | 2·08 |
| Chloride of Potassium | .. | .. | .. | .. | .. | .. |
| Total . . . | 99·97 | 99·97 | 99·98 | 99·96 | 99·97 | 99·97 |

The total sulphur in 1000 grains of these different straws, in the undried state, was as follows :—

| | |
|---|---|
| Straw of white peas on clay . . . . | 3·55 |
| ,, ,, sand . . . . | 3·03 |
| ,, grey peas on clay . . . . | 3·44 |
| ,, ,, sand . . . . | 3·99 |

The composition of these different straw-ashes does not offer any very evident subject for remarks. The differences in the analyses not being sufficient to indicate any fact of importance, we pass on to the analyses of the specimens of beans grown on the same soils.

## Beans.

Percentage of Water and Ash in three Specimens of Heligoland Beans.

| | Water. | | Ash. | | Ash on dry. |
|---|---|---|---|---|---|
| Seed . . . . . . . . | 13·20 | .. | 2·54 | .. | 2·90 |
| Produce on clay . . . | 14·20 | .. | 2·53 | .. | 2·94 |
| Produce on sand . . . | 15·80 | .. | 2·80 | .. | 3·33 |

The composition of the ash is as follows :—

Composition in 100 parts of the Ash of Heligoland (or Tick) Beans.

| | No. 1. Seed. | No. 2. Produce on Clay. | No. 3. Produce on Silicious Sand. | Mean. |
|---|---|---|---|---|
| Silica . . . . . . | 1·52 | 0·41 | 0·40 | 0·78 |
| Phosphoric Acid . . | 33·74 | 36·68 | 26·88 | 32·43 |
| Sulphuric Acid . . | 4·28 | 3·15 | 3·05 | 3·49 |
| Carbonic Acid . . | 1·63 | 3·44 | 0·83 | 1·97 |
| Lime . . . . . . | 12·06 | 5·83 | 13·28 | 10·39 |
| Magnesia . . . . | 6·00 | 5·68 | 6·52 | 6·07 |
| Peroxide of Iron . . | 0·65 | 0·12 | 0·59 | 0·45 |
| Potash . . . . . . | 36·72 | 43·36 | 45·69 | 41·92 |
| Soda . . . . . . | 0·14 | 1·30 | .. | 0·43 |
| Chloride of Sodium . | 3·26 | .. | 1·83 | 1·70 |
| Chloride of Potassium | .. | .. | 0·90 | 0·30 |
| Total . . . . | 100·00 | 99·97 | 99·97 | 99·98 |

Total Sulphur of the Heligoland Beans.

| | Seed. | | Produce on Clay. | | Produce on Sand. |
|---|---|---|---|---|---|
| Sulphur in 1000 grains of undried beans | 3·980 | .. | 2·000 | .. | 2·100 |

## Mazagan Beans.

Percentage of Water and Ash in Specimens of Mazagan Beans.

| | Water. | | Ash. | | Ash on dry. |
|---|---|---|---|---|---|
| Seed . . . . . . . . | 17·00 | .. | 2·85 | .. | 3·43 |
| Produce on clay . . . | 11·00 | .. | 2·68 | .. | 3·01 |
| Produce on sand . . . | 16·50 | .. | 2·48 | .. | 2·97 |

Composition in 100 parts of the Ash of Mazagan Beans.

| | No. 1. Seed. | No. 2. Produce on Clay. | No. 3. Produce on Silicious Sand. | Mean. |
|---|---|---|---|---|
| Silica . . . . . . | 2·18 | 0·74 | 0·04 | 0·98 |
| Phosphoric Acid . . | 29·94 | 30·61 | 33·35 | 31·31 |
| Sulphuric Acid . . . | 5·11 | 6·18 | 5·28 | 5·51 |
| Carbonic Acid . . . | 2·59 | 2·80 | 0·34 | 1·91 |
| Lime . . . . . . | 7·69 | 4·79 | 8·24 | 6·91 |
| Magnesia . . . . . | 7·68 | 5·62 | 7·69 | 7·00 |
| Peroxide of Iron . . | 0·36 | 0·12 | 0·34 | 0·27 |
| Potash . . . . . . | 42·88 | 43·52 | 40·66 | 42·35 |
| Soda . . . . . . | 1·57 | 2·40 | .. | 1·32 |
| Chloride of Sodium . . | .. | 3·17 | 2·79 | 1·99 |
| Chloride of Potassium . | .. | .. | 1·25 | 0·42 |
| Total . . . . . | 99·97 | 99·98 | 99·98 | 99·97 |

Total Sulphur in Mazagan Beans.

| | Seed. | | Produce on Clay. | | Produce on Sand. |
|---|---|---|---|---|---|
| Sulphur in 1000 grains of undried beans | 2·210 | .. | 2·280 | .. | 2·501 |

Percentage of Water and Ash in the Straw of Heligoland and Mazagan Beans (the Pods being included).

| | Water. | | Ash. | | Ash. on dry. |
|---|---|---|---|---|---|
| Heligoland, on clay . . . . | 11·04 | .. | 5·17 | .. | 5·81 |
| ,, ,, sand . . . . | 8·12 | .. | 4·64 | .. | 5·05 |
| Mazagan, on clay . . . . | 10·81 | .. | 6·47 | .. | 7·24 |
| ,, ,, sand . . . . | 9·58 | .. | 6·05 | .. | 6·69 |

Composition in 100 parts of the Ash of Bean-Straw on Clay and on Sand.

| | Straw of Heligoland Beans. | | Straw of Mazagan Beans. | | Mean of | |
|---|---|---|---|---|---|---|
| | On Clay. | On Sand. | On Clay. | On Sand. | Straw of Heligoland | Straw of Mazagan. |
| Silica . . . . . | 2·22 | 4·44 | 1·50 | 7·31 | 3·33 | 4·40 |
| Phosphoric Acid . . . | 6·54 | 3·29 | 11·15 | 8·40 | 4·91 | 9·78 |
| Sulphuric Acid . . . | 1·41 | 5·44 | 3·88 | 2·10 | 3·43 | 2·99 |
| Carbonic Acid . . . | 24·39 | 22·64 | 25·73 | 18·15 | 23·52 | 21·94 |
| Lime . . . . . . | 18·89 | 22·44 | 18·26 | 25·57 | 20·66 | 21·92 |
| Magnesia . . . . . | 3·13 | 4·66 | 4·86 | 6·87 | 3·90 | 5·86 |
| Peroxide of Iron . . | 0·70 | 0 50 | 0·42 | 1·98 | 0·60 | 1·20 |
| Potash . . . . . . . | 18·75 | 25·61 | 19·55 | 21·10 | 22·18 | 20·33 |
| Soda . . . . . . . | 13·94 | 4·09 | .. | 0·21 | 9·02 | 0·11 |
| Chloride of Sodium . . | 10·00 | 6·88 | 11·02 | 8·31 | 8·44 | 9·67 |
| Chloride of Potassium . | .. | .. | 3·59 | .. | .. | 1·79 |
| Total . . . . | 99·97 | 99·99 | 99·96 | 100·00 | 99·99 | 99·99 |

The total sulphur in 1000 grains of the undried bean-straw was found to be—

| | |
|---|---|
| Heligoland bean-straw, on clay . . . . . | 2·71 |
| ,, ,, sand . . . . . | 2·41 |
| Mazagan bean-straw, on clay . . . . . | 3·77 |
| ,, ,, sand . . . . . | 2·05 |

We have already said that it would be unsafe to draw from these limited analyses any decided conclusions in respect to the influence of *soil* or *variety* on the mineral composition of the plant. But at the same time they are sufficient in number to afford perfectly satisfactory data for the average composition of the ashes of the grain and straw of peas and beans; and perhaps we could not better conclude this Report than by placing for comparison, in a tabular form, the *mean* analyses before given.

Mean composition of the Ash of Peas and Beans, and of their Straws (including the Pods).

| | Peas. | Beans. | Pea-Straw. | Bean-Straw. |
|---|---|---|---|---|
| Silica . . . . . . | 1·24 | 0·88 | 5·36 | 3·86 |
| Phosphoric Acid . . | 34·81 | 31·87 | 4·50 | 7·35 |
| Sulphuric Acid . . | 5·68 | 4·50 | 5·66 | 3·21 |
| Carbonic Acid . . | 1·82 | 1·94 | 14·74 | 22·73 |
| Lime . . . . . . | 6·32 | 8·65 | 37·99 | 21·29 |
| Magnesia . . . . | 6·57 | 6·55 | 6·73 | 4·88 |
| Peroxide of Iron . . | 0·59 | 0·36 | 1·76 | 0·90 |
| Potash . . . . . . | 40·19 | 42·13 | 17·17 | 21·26 |
| Soda . . . . . . | 0·65 | 0·90 | 2·48 | 4·56 |
| Chloride of Sodium . | 0·68 | 1·90 | 3·57 | 9·05 |
| Chloride of Potassium | 1·42 | 0·34 | .. | 0·90 |
| Total . . . | 99·97 | 100·00 | 99·96 | 99·99 |

The averages in the foregoing table are, it will be remembered, those of 6 analyses of peas and 6 of beans, and 4 analyses of pea-straw, and the same number of bean-straw. The mineral composition of peas and of beans is, then, remarkably similar: their respective straw-ashes do not so closely resemble each other, but are still of the same character.

*On the methods of Preparing and Analysing the Ashes of Plants.*

In the preceding Report in this Journal we have alluded to the questions which have been raised concerning the accuracy of the ordinary methods of burning plants for ash analysis.

The substances which it would be possible, according to known chemical phenomena, to dissipate in the combustion of the plant are—carbonic acid, sulphuric acid, phosphoric acid, and chlorine, and the metallic bases of the alkalies potash and soda. The other constituents of plant-ashes—namely, silica, oxide of iron, lime, and magnesia—cannot, it is conceived, be liable to loss in any form.

*1st. Of Carbonic Acid.*

Rose, to whose paper on this subject we have before referred, has pointed out discrepancies in regard to this constituent which are found to occur in the analyses of plants by different chemists, and, by reference to the alleged composition of the blood, has shown how very necessary it is that some better method should be adopted in order to obtain coincident results. It must be remembered that, although carbonic acid is not an actual constituent of a vegetable or animal substance, but is produced in the combustion, a knowledge of the quantity in different ashes is of importance in the discussion of many physiological questions,

inasmuch as it is supposed to be a measure of the organic acids in combination with the different bases before combustion. We may shortly consider what is the probability that, by the usual methods of burning, uniform results should be obtained in regard to the quantity of this acid. In the case of *silicious* ashes it must be at once allowed that there is no hope of so regulating the temperature to which the ash is exposed as to avoid the displacement of carbonic acid to a greater or less extent by the more powerful silicic acid. It is, we believe, verily *impossible* at any available temperature to burn a silicious vegetable, such as wheat-straw or barley-straw, to a moderately white ash without action of this sort; the silica is so finely divided, and, as the process advances, so intimately mixed with the other constituents, that an alteration from the cause in question is unavoidable; indeed, the absence of carbonic acid in any quantity in nearly all reported analyses of plants in which silica is an important constituent, and the necessity which analysts always experience of subjecting a silicious ash to particular treatment to decompose insoluble silicates, are indirect proofs of the justice of this statement.

It must then, we believe, be admitted that no coincident results in the quantity of carbonic acid are to be looked for in the case of silicious ashes by the ordinary methods of burning.

The question next presents itself—does the careful preparation of non-silicious ashes give uniform results in regard to carbonic acid, and is it possible to use these results as data indicative of the proportion of organic acids existing in the plants before incineration?

In the absence of silica, which is the only *uncombined* mineral acid in plants, we should suppose that no other constituent would be liable to vitiate the determination of carbonic acid, were it not that phosphoric acid combines in different proportions with bases, and, until it has reached its point of saturation, may be supposed to be capable of acting as an acid.

The point to be decided is—are phosphates containing *less* than three proportions of base capable of attacking carbonates and driving off the carbonic acid? In proof of the affirmative answer to this proposition, Rose has quoted the experiments of Golding Bird, who produced the basic phosphate of soda ($3\,NaO + PO_5$) by heating to redness a mixture of the ordinary phosphate of soda with acetate of soda. The following experiment by ourselves is confirmatory of Rose's statement:—

40·64 grains of pyrophosphate of soda, strongly dried, were mixed with 53·30 grains of pure carbonate of soda (also strongly heated). A gentle heat was applied to the mixture by a gas-flame; it lost 3·83 grains; by a second heating at a higher temperature in a furnace, the salts being in partial fusion, 2 grains more were

lost, or 5·83 altogether: further heating did not appear to alter the weight. If the pyrophosphate of soda decomposed an entire equivalent of carbonate of soda, the loss for 40·64 grains should have been 6·70 grains. The loss fell somewhat short of the calculated quantity, but it is plain that a *bibasic* phosphate will at a high temperature become *tribasic* at the expense of a carbonate. Of course the argument applies with greater force to mono-basic phosphates, and we must conclude that phosphates with less than three atoms of base will, to a greater or less extent, act upon the carbonates of the ash, and thus vitiate the results as far as this acid is concerned. That such phosphates really exist in plants there can be little or no doubt. The method proposed by Professor Rose, of treating the *charred* vegetable by water and estimating the alkaline carbonate in the solution, can but partially remedy this defect, for it leaves the insoluble *earthy* carbonates quite undetermined, since no chemist would attempt to estimate in the usual way the small amount of these latter carbonates which may be distributed through many thousand grains of charcoal.

It is easy also to see that the quantity of alkaline carbonates thus dissolved would in no way indicate the proportion actually present in the ash, since the character of the solution would be entirely regulated by the proportion of other salts present. Thus, suppose the *ash* to contain sulphate of lime and carbonate of potash, the aqueous solution will yield sulphate and not carbonate of potash, and so on.

In fact, we know of no existing methods of so burning plants as to obtain estimations of the carbonic acid of their ashes which shall at all be indicative of the organic acids present in the vegetable substance examined.

It is so far fortunate that, for all practical purposes, a knowledge of the proportion of carbonic acid is not needed, and, except in a general way, its estimation must be looked upon as a necessary but useless part of plant-ash analysis.

The next acid which might be subject to loss in the combustion of a plant is the *sulphuric*.

It is easy to conceive that the sulphates present in an ash may be decomposed at a high temperature by silica, the sulphuric acid being driven off in vapour.

The following experiment was made with a view of ascertaining the liability to loss from this source:—

45·39 grains of pure sulphate of potash well dried were dissolved in 1000 grains of water, and the solution poured over 2000 grains of barley in a platinum dish; the barley was allowed to digest in the liquid, which was subsequently carefully evaporated to dryness in contact with it; when dry, the barley was burned to

ash; it burned with difficulty, and, the heat being strong, there was a partial fusion towards the last, accompanied by the evolution of white fumes of sulphuric acid. The ash was dissolved in nitric acid, and the sulphuric acid precipitated by nitrate of barytes. The sulphate of barytes weighed 43·32 grains = 14·89 grains sulphuric acid.

| | |
|---|---|
| Sulphuric acid in the sulphate of potash . . | 20·85 |
| „ in the ash . . . . . | 14·89 |
| „ driven off in the burning . . | 5·96 |

It is thus evident that there is liability, in the ordinary method of burning, to loss of sulphuric acid wherever silica is present in any quantity, that is, in all silicious ashes. The temperature at which this occurred was higher than is at all admissible or necessary generally, but still the analyst could never feel sure that the temperature was so perfectly regulated that no loss of sulphuric acid had occurred in the usual way of burning.

So far with regard to loss of sulphuric acid in the preparation of silicious ashes.

It next became necessary to determine whether loss could be occasioned by other ingredients in the absence of a large percentage of silica; and, as before, phosphoric acid and acid phosphates were considered to be the only agents capable of vitiating the results in the burning of non-silicious vegetables.

An experiment was made to ascertain if a phosphate containing two equivalents of fixed base (a pyrophosphate) was capable of decomposing a sulphate. For this purpose a mixture was made of pyrophosphate of soda and sulphate of potash, both previously strongly heated, in the following proportions:—

| | |
|---|---|
| Sulphate of potash . . . | 47·86 |
| Pyrophosphate of soda . . | 37·74 |
| | 85·60 |

These materials were perfectly mixed, and heated to redness in the air-flame of a gas-lamp for two hours, at the end of which time no loss of weight had occurred. The mixture was then introduced into a furnace and more strongly heated, till the materials were fused into a limpid liquid. Upon cooling, the mixture was found to have undergone no change of weight. A second experiment gave similar results. A phosphate of two atoms of fixed base is therefore incapable of decomposing a sulphate or of causing loss of sulphuric acid in an ash.

An experiment was next instituted to ascertain if a mono-basic phosphate would exercise any influence upon the sulphate of an

ash. Microcosmic salt was heated to redness, and the resulting metaphosphate mixed with sulphate of potash:—

| | |
|---|---|
| Metaphosphate of soda ($Na\,O\,P\,O_5$) . . | 23·57 grains. |
| Sulphate of potash . . . . . | 32·06 |
| | 55·63 |

The materials were strongly fused till they became liquid. On cooling, the weight was 55·54. We considered this loss of ·09 evidently due to error of experiment, and did not think it necessary to repeat the trial. It is therefore plain that a phosphate with *one* equivalent of fixed base is equally unable with a pyrophosphate to drive off sulphuric acid from an ash. And we may at once decide that there is no reason for fearing a loss of *sulphuric acid* in any non-silicious ashes.

But is the whole sulphur of plants necessarily present in them as *sulphuric acid?* or, if not, does it follow that it should become sulphuric acid in the burning? Our knowledge of the composition of the nitrogenous compounds of plants would lead us to answer the first question in the negative. The gluten, albumen, &c. of plants is known to contain sulphur—if not *quasi* sulphur, still in some other form than as sulphuric acid; and the experiments we are about to bring forward prove that the sulphur is not really retained in the ash, but that a very large proportion of it (in some cases amounting to two-thirds of the whole quantity) is dissipated in the burning.

The following experiments prove that slight differences in the method of burning a plant give very dissimilar quantities of sulphuric acid in the ash.

Of course, a non-silicious vegetable was employed, and, as a matter of convenience, turnip-seed was chosen for experiment. One thousand grains of turnip-seed were burnt in a large platinum dish in the usual way, a temperature scarcely reaching dull redness being employed; the ash was dissolved in nitric acid, and the sulphuric acid estimated as sulphate of barytes in the usual way:—

Sulphuric acid in the 1000 grains of turnip-seed . 2·944

Three other experiments were made on equal quantities of the same seed, the temperature, the length of time in burning, &c. being as far as possible the same in all. The results were as follow:—

| | |
|---|---|
| 2nd experiment, sulphuric acid in 1000 grains of turnip-seed . . . . . | 2·710 |
| 3rd ,, ,, ,, ,, | 2·960 |
| 4th ,, ,, ,, ,, | 3·460 |

It is plain, therefore, that with all possible attention to the burning of vegetable substances, the quantity of sulphuric acid in the ash is anything but constant in different burnings of the same non-silicious plant. It was thought that the rapidity or otherwise with which the first part of the combustion was conducted would, in all probability, very materially affect the results.

One thousand grains of the turnip-seed were perfectly dried and suddenly introduced into the platinum basin already red-hot: it caught fire immediately and burnt with much flame; the burning was continued as usual, and the ash analysed: it gave 2·260 of sulphuric acid.

One thousand grains were thoroughly dried and subsequently very gradually charred by immersion of the platinum dish in hot sand; it did not catch fire at all. The charred mass was carefully and slowly burnt to ash; it gave 4·680 of sulphuric acid. Another experiment, precisely similar in conduct, gave 5·700.

It would seem, then, that great *rapidity* of burning dissipates more sulphur, whilst a careful avoidance of inflaming the plants gives the highest proportion of sulphuric acid in the ash.

But at the same time it will at once be manifest that even this modification of the process of burning, although it retains the most sulphur, gives results anything but uniform or correct; and we convinced ourselves of the fact that sulphur passes off from a burning animal or vegetable substance in combination with hydrogen. This evolution of sulphuretted hydrogen takes place at the lowest temperatures at which it is possible to burn organic substances, and the escape of the gas can be made readily evident by suspending a piece of lead-paper over turnip-seed charred at a dull heat. Conceiving it certain that the sulphur which is dissipated in the burning of plants passes off in the state of sulphuretted hydrogen, we were induced to try whether its oxidation previous to burning would not give more satisfactory results, and no better oxidating medium occurred to us than nitric acid, which was accordingly employed.

One thousand grains of turnip-seed were digested in strong nitric acid, aided by a gentle temperature. The action soon becomes violent, with evolution of abundant fumes of peroxide of nitrogen. After the action had continued some time, but before the further addition of acid had ceased to produce any effect, the materials were turned out of the flask into the platinum dish, gently evaporated to dryness, and subsequently burnt.

The thousand grains of turnip-seed, dissolved in nitric acid and burnt, gave 3·214 sulphuric acid.

This quantity is inferior to that obtained in several experiments before mentioned, where nitric acid was not employed. The method is therefore not attended with any advantage. The

following experiments on white peas afford evidence of a similar nature :—

| | | |
|---|---|---|
| 1000 grains of white peas burnt in the usual way gave . . . . . | 3·357 | sulph. acid. |
| 1000 grains dissolved in nitric acid and then burnt gave . . . . . | 3·611 | ,, |
| A second experiment by the same method . | 2·533 | ,, |

We have mentioned that in these experiments the oxidation by nitric acid was not complete. The following experiments show that even when no further action is produced by nitric acid the burning of the product is attended with the loss of sulphuric acid :—

One thousand grains of white peas were perfectly oxidated by nitric acid, the action being continued till all the organic matter was destroyed. It is found that, as the evaporation proceeds, the product of this action suddenly takes fire, even although the process is very slowly conducted. The 1000 peas, perfectly oxidated by nitric acid and burnt, gave 4·182 of sulphuric acid ; a second experiment gave 4·962 of sulphuric acid. Here it will be seen that the perfect oxidation of the whole vegetable substance by nitric acid does not prevent loss of sulphur in the subsequent burning. It is true that in both these latter experiments the proportion of sulphuric acid in the ash is greatly increased, but the results obtained are not uniform. Such a result was certainly in some measure to be anticipated ; for, supposing that by the oxidation of the sulphur a large amount of sulphuric acid is produced, there is no provision for the union of this acid with the necessary proportion of fixed base in the ash, and it is consequently dissipated in the burning.

The obvious remedy for this defect is to neutralise the acid liquids with an alkaline carbonate previous to burning, and this plan we, for several reasons, prefer to burning the vegetable substance directly with a nitrate or chlorate.

The plant is digested with strong nitric acid, by which it is rapidly attacked. When the substance of it has been broken down into a uniform pulp, the free acid is neutralised by pure carbonate of soda. The mixture is evaporated and carefully burnt.

The ash is then introduced into a deep flask, and treated very gradually by strong nitric acid till it becomes acid. It is important to employ strong nitric acid and a deep rather than an open vessel ; because without these precautions there is a very considerable liability to loss, sulphuretted hydrogen being evolved from the alkaline sulphurets produced in the last stages of the burning. In the manner indicated there is, however, no loss ; of

which fact we have satisfied ourselves by passing the gas through acetate of lead, which remained unaltered.

For the purpose of showing that this method gives uniform results, we subjoin some experiments made upon white mustard-seed, which was chosen as likely to afford a large proportion of sulphur :—

| | |
|---|---|
| 1000 grains of white mustard-seed burnt in the usual way gave . . . . . | 4·200 sulph. acid. |
| 1000 grains digested in nitric acid for a sufficient time to form a pulp, neutralised with carbonate of soda, and burnt, gave . | 30·038 ,, |
| 1000 grains dissolved in nitric acid, and fresh additions of acid made with heat till all signs of oxidation had ceased, neutralised with carbonate of soda, and burnt, gave . | 29·886 |
| 4th experiment, same as the preceding. . | 30·017 ,, |

These experiments prove not only that the whole of the sulphur in the vegetable substance may be obtained by the methods in question, but that it is immaterial to what extent the oxidation is carried, so that the plant is eventually burnt in an excess of a nitrate. The solution in nitric acid and subsequent neutralisation must be regarded merely as a means of procuring a thorough incorporation of the nitrate with the vegetable matter, a point which is very essential, and is admirably attained by the method employed.

We also instituted some experiments to ascertain how far it was possible to dispense altogether with the neutralisation of the acid product by carbonate of soda previous to burning. For this purpose white mustard-seed was digested in a flask with strong nitric acid, a slight heat being applied. Frequent additions of the acid were made until the action had comparatively ceased; the acid liquid was then boiled until the evolution of red vapours had entirely discontinued; the liquid was diluted and nitrate of barytes added. After standing for some hours the precipitate was collected and burnt; after being weighed it was digested in hydrochloric acid, to dissolve some carbonate of barytes due to organic salts of this base, and the pure sulphate again collected, burnt, and weighed.

The following results were obtained by this method :—

| | |
|---|---|
| 1000 grains of white mustard-seed perfectly oxidated by nitric acid gave . . | 29·844 of sulph. acid. |
| A second experiment, conducted in the same way precisely, gave on 1000 grains . | 29·726 of sulph. acid. |

It was desirable to ascertain whether a less amount of oxidation

by nitric acid would give the true quantity of sulphur. The following experiment is unfavourable to this idea:—

One thousand grains of white mustard-seed were digested in strong nitric acid, the action being carried only so far as to break down the seed into a uniform pulpy mass; the acid liquid was diluted with water and the whole allowed to digest for 24 hours; it was then filtered and precipitated by nitrate of barytes.

It gave . . . 27·880 of sulphuric acid.

This is less than the true quantity of sulphuric acid; and although it is impossible to say at what particular point the whole sulphur of the plant is converted into sulphuric acid, we should not conceive it safe to stop so far short of perfect oxidation of the vegetable substance. At the same time, as the following experiment shows, it is quite possible to obtain the whole sulphur of the plant without carrying on the operation to perfect oxidation. One thousand grains of white mustard-seed were treated with strong nitric acid, and fresh additions of acid made until the action, though not by a good deal complete, had yet lost much of its violence; the acid liquid was diluted and filtered, and precipitated by nitrate of barytes, as usual.

It gave . . . 29·672 of sulphuric acid.

It is fair to state that this method of oxidating sulphur, which is common enough in chemical operations, has been before applied to the estimation of the sulphur of plants. A series of estimations of the sulphur and phosphorus of plants, extending over a large number of specimens, and conducted apparently with great care, is published in the 'Memoirs of the Chemical Society' (part xx.), by Mr. Clifton Sorby. The results there given differ from our own considerably in some instances, although but little weight is due to this circumstance, seeing that no two specimens have been found by us precisely alike. From the account of the process given in the Memoirs we are inclined to think that Mr. Sorby may not in all cases have obtained the whole sulphur of the plant for want of a more perfect oxidation than he seems to have attained. And indeed, however satisfactory this method may be in the case of seeds, it is radically defective for the estimation of sulphur in some other vegetable substances, such as straw, leaves, &c.

We had commenced a series of examinations of the straws of beans and peas by this plan, but were compelled to abandon the experiments on account of the great want of uniformity in the results. In some cases scarcely a trace of sulphate of barytes was obtained, when the acid liquid, after treatment with nitrate of barytes, had been allowed to stand for many days—in other

instances the precipitate was abundant. Our experience leads to the conclusion that the neutralization by an alkali, previous to burning, should never be omitted.

We think, then, that the evidence we have adduced is sufficient to prove—

1st. That sulphuric acid, *as such,* is liable to a greater or less extent to be driven off in the burning of all silicious plants.

2nd. That in the combustion of non-silicious plants (as, of course, also of those of a silicious character) there is always a loss of sulphur not existing as sulphuric acid in such plants.

3rd. That this loss of sulphur is very variable in different experiments, depending upon a variety of circumstances over which the operator can exercise no distinct control.

4th. That as it appears that phosphates have no action upon the sulphates of the ash, the sulphuric acid afforded by an ordinary burning of a non-silicious plant must represent the *full* quantity of that acid actually existing in the plant; but—

5th. That inasmuch as the (*quasi*) sulphur retained in the ash burnt in the usual way is not a constant quantity, no inferences can be drawn as to the real sulphuric acid of the plant by this estimation.

And lastly, that although combustion with a nitrate gives the total sulphur in any substances under examination, we are still unable from either or both of these determinations to state how much of the sulphur existed as sulphur and how much as sulphuric acid in the plant. We know, indeed, that in the case of non-silicious ashes the *excess* of sulphuric acid by the nitrate process must have existed as sulphur in the subject of analysis, but we cannot say that this excess really represents the whole of that element in the plant, for, in point of fact, we know that a variable quantity is converted into sulphuric acid in the combustion. We entertain little doubt that we may eventually devise some method of distinguishing the *sulphuric acid* of the plant from its *sulphur,* but at present we are not in possession of a process adequate to that end. In the meanwhile, for many practical purposes the knowledge of the total sulphur will, it is hoped, be of considerable value.

We have next to consider whether the phosphoric acid of plants is liable to any loss by the usual methods of burning. There can be no doubt that this is by far the most important point in the whole inquiry, and as such we have bestowed particular attention upon its discussion.

As in the former cases, loss of phosphorus would be more likely to occur in silicious than non-silicious ashes, but we will take the simplest question first.

Wheat, peas, white mustard-seed, and turnip-seed were selected as non-silicious ashes for trial:—

| | Phos. Acid. |
|---|---|
| 1000 grains of wheat burnt in the usual way afforded . . . . . . | 6·14 |
| 1000 grains digested in nitric acid and subsequently burnt gave . . . . . | 6·34 |

It is to be observed, as all chemists will at once understand, that the estimation of phosphoric acid does not admit of such perfect accuracy as that of other substances, as that of sulphuric acid for instance. A greater amount of latitude must therefore be allowed for the results in this case than in that of the acid just described.

*Turnip-seed.*

| | Phos. Acid. |
|---|---|
| 1000 grains of turnip-seed burnt in the usual way gave . | 12·16 |
| 1000 grains of turnip-seed digested in nitric acid and then burnt gave . . . . . . | 12·56 |

*White Peas.*

| | | |
|---|---|---|
| 1000 grains of peas burnt in the usual way gave . . . . . . | 4·975 | |
| A second experiment on the ash of this burning . . . . . | 4·810 | |
| | | mean 4·892 |
| 1000 grains of white peas digested in nitric acid for some time and then burnt:— | | |
| First burning. | Phos. | |
| 1st analysis . . . . . . | 4·975 | |
| 2nd " . . . . . . | 5·000 | |
| 3rd " . . . . . . | 5·065 | |
| | | mean 5·010 |
| 2nd experiment—1000 grains of peas dissolved in nitric acid and burnt:— | | |
| 1st analysis . . . . . | 4·950 | |
| 2nd " . . . . . | 5·025 | |
| | | mean 4·987 |
| 3rd experiment—1000 grains of peas dissolved in nitric acid and the action maintained till perfect oxidation was produced. The materials took fire spontaneously whilst evaporating at a low temperature . | | 4·800 |
| Another experiment on 1000 grains of peas perfectly oxidated by nitric acid gave . . . . | | 5·08 |

*White Mustard-seed.*

| | |
|---|---|
| 1000 grains of white mustard-seed burnt in the usual way gave . . . . . . . | 18·32 |

| | Phos. Acid. |
|---|---|
| 1000 grains of white mustard-seed digested in nitric acid, neutralised by carbonate of soda, and burnt, gave . . . . . . . . | 18·04 |
| 1000 grains *perfectly oxidated* by nitric acid, neutralised by carbonate of soda, and burnt, gave . | 18·25 |

A review of these results, we hope, will be considered to justify us in asserting that the ordinary methods of burning give perfectly accurate results for phosphoric acid in non-silicious ashes; incidentally they are satisfactory in proving the correctness of the methods employed in the *analysis* of the ashes when prepared, but of this we shall speak further on. We must, however, in this place slightly advert to the great doubt which the experiments described cast upon the opinion that phosphorus *as such* exists in the organic compounds of vegetables; we know that phosphorus forms with hydrogen a compound similar in composition and many of its characters to sulphuretted hydrogen. If in the burning of plants *unoxidated* sulphur escapes in variable proportions, why should not unoxidated phosphorus, supposing it to exist, be equally dissipated in the combustion? In point of fact, in all the experiments given above, however varied may have been the burning, the resulting phosphoric acid has been found identically the same. Burnt in the usual way, or in a highly oxidating medium, the results have, within the limits of errors of analysis, proved perfectly coincident. We cannot reconcile these facts with any theory which would suppose phosphorus to be present in vegetable structures in the same unoxidated form as we find sulphur to hold in them.

But we have yet to consider whether in *silicious* ashes any loss of phosphorus can occur. Rose has rather hinted at the possibility of this occurrence than asserted that it actually does take place; he supposed that phosphoric acid may be separated from its basis by silica, robbed of its oxygen by charcoal, and volatilized as phosphorus.

Reviewing the experiments just described, and calling to mind the tenacity with which phosphoric acid retains its last equivalent of base, and the very high temperature which is required for the reduction of the acid in the manufacture of phosphorus, a temperature which no careful analyst would dream of employing in the preparation of plant-ashes—taking these points into consideration, we might anticipate with safety that the result of the investigation would in this case be also in favour of the ordinary methods of burning. We have, however, some more definite evidence to offer on this point.

Barley, the ash of which contains about 30 per cent. of silica,

and fully as much of phosphoric acid, was thought very suitable for this experiment:—

| | Phosphoric Acid. |
|---|---|
| 1000 grains of barley were burnt in the usual way, and gave | 10·61 |
| 1000 grains dissolved in nitric acid and then burnt gave . | 10·19 |
| 1000 grains of another specimen of barley* were burnt in the usual way and gave . . . . . . . . . . . . . | 7·96 |
| 1000 grains of the same barley were charred at a low temperature and the charred mass deflagrated with nitrate of barytes; it gave . . . . . . . . . . . . . . | 7·52 |
| Another specimen of barley was burned in the usual way, and three analyses of its ash made:— | |
| 1st Analysis, 1000 grains gave . . . . . | 10·89 |
| 2nd ,, 1000 ,, . . . . . | 10·56 |
| 3rd ,, 1000 ,, . . . . . | 10·50 |
| 1000 grains of the same barley nearly oxidated by nitric acid, the acid liquid neutralized by carbonate of soda, and afterwards burnt; it gave. . . . . . . . . . . . | 10·90 |

A specimen of Moldavian barley, which afforded 2·93 per cent. of ash, was burned in the usual way—the ash gave 30·08 per cent. of phosphoric acid. Another portion was oxidated by nitric acid; the liquid was neutralized by carbonate of soda, and the product burned: the phosphoric acid calculated on the ash was found to be 29·92 per cent. In this instance the barley was fully burned, there being in the ash obtained by the ordinary method not more than 3 per cent. of charcoal. It is plain, however, that no phosphoric acid had been lost.

We do not, then, think it worth while to carry the evidence further, with the view of proving that in no form is phosphorus lost in the burning of plants. The discrepancies observable in these analyses are such as are inseparable from the estimation of phosphoric acid, at all times difficult, but peculiarly so in the case of plant-ashes; the differences, too, are often in an opposite sense, that is, an ash obtained by the use of an oxidating medium sometimes gives on analysis rather less than more phosphoric acid, evidently due to imperfections in the available methods of determining the quantity of this acid.

The conclusion we have arrived at is, that in no kind of plant and under no circumstances does the ordinary method of combustion lead to the loss of phosphorus in any form, provided only that a moderate temperature be employed. For any other case

* These specimens form part of a series grown under very different and unnatural conditions; hence the variation in $PO_5$ in the two specimens. This circumstance we conceived to fit them better for our experiments.

we do not feel called upon to legislate; it is just possible that an *intense* heat may reduce and dissipate phosphorus, although in an open shallow dish, with free exposure to air, the result is more than questionable, but such a heat would be equally unnecessary and inadmissible in the combustions in question.

We come now to consider whether or not *chlorine* is lost in the burning of plants for analysis. This substance, which usually exists in plants as chloride of sodium (common salt) or potassium, is in a practical point of view perhaps less important than either of the two acids just discussed. It is certainly true that common salt is found in large quantities in some plants, more particularly those of a succulent watery character, the analyses of turnip-beet, &c., given in the Journal, showing a proportion of the salt, in some cases equal to nearly or quite one-half of the entire ash. But as yet we have no evidence to show that common salt (or chlorine in any form) is an indispensable ingredient of plant-ashes, for it will be remembered that in the seeds of plants it is very frequently altogether wanting, and there is some reason to believe that its absence is connected with the perfect ripeness of the specimens.

Whether chlorine is or is not an essential ingredient of plants, whether it is useful as an *agent* in vegetable nutrition, or wholly unimportant in these respects, we do not here propose to consider.

Loss of chlorine in the burning of ashes, if it occur at all, may arise from two or three causes. It may possibly be given off as hydrochloric acid in the early stages of the combustion; it may, as Rose has pointed out, be driven off by the action of the acid phosphate in the ash; or, lastly, it may be lost by the volatilization of chloride of sodium or potassium.

The following experiments were made with a view of ascertaining how far the alkaline phosphates containing less than 3 proportions of base are capable of decomposing the chlorides:—

The ordinary phosphate of soda was taken as the type of phosphates containing 2 atoms of fixed base, but as it was considered that in all probability the evolution of chlorine would take place as hydrochloric acid due to the basic water of the phosphate, the phosphate was not further dried than to render it more manageable in the subsequent heating.

Ordinary phosphate of soda was dried on paper till the fused salt became tolerably solid; 23·44 grains of the salt heated by an air-flame of gas-lamp lost 8·32 grains of water, or 35·49 per cent. (the crystallized phosphate contains 62·63 per cent. of water). Of this phosphate 69·48 grains were mixed with 29·24 grains, perfectly dry, of common salt, gently heated at first, and subsequently over the air-flame to redness; the loss was 23·90: by

further and stronger heating a further loss of ·08 was produced. The covered crucible was now introduced into a furnace and strongly heated; the materials were fused into a transparent liquid and kept in that state for 10 minutes; on cooling, the weight was found to be undiminished. The total loss of weight in the experiment was, therefore, 23·98; the loss which should occur from the water in the phosphate 24·65: so that in point of fact the diminution of weight was not quite so great as it should have been from the known proportion of water in the salt used. We considered this slight difference due to error in the experiment, which we did not think it necessary to repeat.

Phosphates containing two atoms of fixed base with one of water are not therefore capable of decomposing a chloride at a high temperature. It was considered necessary to extend the experiment to a salt of this composition, but in which the basic water is replaced by ammonia, that is, the ammonio-phosphate of magnesia ($2\ MgO,\ NH_4O,\ PO_5$). This salt is generally believed to exist in all seeds, and from its composition we were led to believe that it might with chloride of sodium afford more affirmative results than the ordinary phosphate.

18·84 grains of ammonio-phosphate of magnesia were heated to redness; it lost 8·43 grains.

34·14 grains of the same phosphate and 38·04 grains of common salt were heated together over a gas-lamp; the mixture lost 27·14 grains.

Introduced into a furnace and perfectly fused, a further diminution of 0·45 occurred, making the entire loss 27·59.

Had the loss of weight been confined to the ammonio-magnesian phosphate, it would have been only 15·28; so that a very considerable dissipation of chlorine had here occurred, in all probability going off in the form of sal-ammoniac.

It may, however, well be doubted whether the ammonio-phosphate of magnesia is likely to occasion a loss of chlorine in the burning of plants for ash analysis, since from its ready decomposition by heat it is most probably destroyed long before the organic matter of the plant has been sufficiently removed to allow of contact between the salts enveloped in it. There is still another class of phosphates to examine, in reference to their action on the alkaline chlorides, namely, the phosphates with one equivalent of fixed base and one or more of water, like the biphosphate of soda:—

6·41 grains of crystallized microcosmic salt ($HO,\ NH_4O,\ NaO,\ PO_5+8\ HO$) were heated, and lost 3·29 grains, or 51·32 per cent. (The theoretical loss of the salt is 51·03.)

26·40 grains of the microcosmic salt were mixed with 36·62

grains of heated common salt; the mixture when gently heated lost 15·54, heated still more it lost 16·08, perfectly fused 16·41, or 62·10 per cent. on the microcosmic salt.

The smell of hydrochloric acid was very distinct, and moistened litmus-paper held over the capsule was reddened by the fumes. The fused salt dissolved in water gave a pure white precipitate with nitrate of silver, showing that it had not assumed *more* than one proportion of soda from the chloride.

Microcosmic salt loses its ammonia at a low temperature; a little additional heat will then drive off its equivalent of basic water. It might be thought that the loss of chlorine in this experiment was attributable to the ammonia (as in the instance before given of the ammonio-phosphate of magnesia), but it was evident that the chlorine escaped as hydrochloric acid, and it would seem that the basic water is retained until the heat becomes sufficient to effect this change. It is plain that phosphates cannot decompose the alkaline chlorides otherwise than by the help of the water which they contain; and there is good reason for believing that in the burning of plants this water is dissipated by the heat long before the mineral substances of the ash can have been brought in sufficient contact to enable them to act upon each other.

In order to decide by actual experiments the liability to loss of chlorine from the two first causes, that is to say, from volatilization in the early burning, or by the subsequent action of the phosphates of the ash, the following experiments were made:—

A specimen of turnip was dried and powdered.

424 grains of this specimen were burned to ash in the usual way, and at fully the temperature ordinarily employed by us in the preparation of ashes.

The ash was dissolved by nitric acid and water, filtered, and precipitated by nitrate of silver; the chloride of silver weighed 1·55 grains, equal to ·382 chlorine, or ·0901 per cent. on the dry turnip.

A second quantity of 424 grains of turnip was *charred* at a very low temperature in a covered platinum vessel; the charred mass was powdered, treated with boiling water and a few drops of nitric acid, and thoroughly washed. The washing occupied much time and required a large quantity of water. The chlorine was precipitated by nitrate of silver; the chloride of silver weighed 1·69 grains, equal to ·417 chlorine, or ·0983 per cent. on the dry turnip.

This particular turnip contained 10·5 per cent. of ash, so that the comparative results may be thus stated:—

| | On the Dry Turnip. | On the Ash. |
|---|---|---|
| Chlorine by *charring* . . . . | ·0983 per cent. | ·937 per cent. |
| ,, by burning to ash . . . | ·0901 ,, | ·859 ,, |

In the following experiments it was sought to compare the chlorine of ashes obtained at different temperatures:—

300 grains of another specimen of powdered turnip were burnt to ash over the air-flame of a gas-lamp; the ash was treated with nitric acid and water, and the residue of charcoal, &c. again burnt until it was perfectly white; the liquid precipitated by nitrate of silver gave 1·180 chloride of silver, equal to ·290 chlorine.

A second experiment on 300 grains, performed as nearly as possible in the same way, gave 1·270 chloride of silver, equal to ·313 chlorine.

In a third experiment the 300 grains of turnip were burnt to ash in the laboratory furnace; the temperature in this case was far higher than in the two former experiments, and the ash remained fused for some time. It yielded, when treated as in the former cases, 1·070 chloride of silver, equal to ·264 of chlorine.

The experiment may be thus stated:—

Chlorine on 1000 grains of dry turnip.

| | | |
|---|---|---|
| Burnt at a low temperature without fusion of the ash. . . . . | 1st Experiment | ·966 |
| | 2nd ,, | 1·040 |
| Burnt at a high temperature with considerable fusion of the ash . . . . . . . . . . . . | | ·880 |

The two first results are almost identical; the third gives certainly less than the true quantity of chlorine, but it is to be understood that the temperature was purposely allowed to become much higher than is at all necessary, and even in these conditions the loss is comparatively small. In the following experiments the substance was in each case burned as nearly as possible at the temperature usually employed in the preparation of ashes:—

500 grains of powdered turnip* were burned at a moderate heat in the furnace. It yielded 2·240 of chloride of silver, equal to ·5525 chlorine, or 1·1050 on 1000 grains of the dry turnip.

A second quantity of 500 grains burnt at the same temperature. It gave 2·190 chloride of silver, equal to ·5402 chlorine, or 1·0804 on 1000 grains of turnip.

This difference is plainly within the limits of error of experiment, and we must consider the results as identical. It is therefore quite possible to obtain coincident results in regard to chlorine by careful burning. The following experiments indicate the amount of loss occurring when an unusually high temperature is employed:—

* The same specimen as the last, but by remaining in a warm room it had become somewhat drier; hence the trifling increase in per centage of chlorine.

500 grains of turnip burnt over the gas-lamp gave 1·67 of chloride of silver = ·412 of chlorine, or ·824 on 1000 grains of turnip.

500 burnt at a very high temperature in the furnace, and the heat maintained for more than half an hour, gave 1·40 chloride of silver = ·3445 chlorine, or ·689 on 1000 grains of turnip.

The experiments here detailed might be thought conclusive on the subject, but we were anxious to ascertain whether in the presence of a larger per centage of phosphoric acid, with also a greater absolute quantity of a chloride, and still further with a *silicious* ash, the loss of chlorine in burning would be of consequence. An *artificial* subject for experiment was therefore made in the following manner:—

26·39 grains of common salt and 45·39 grains of sulphate of potash* were dissolved in 1000 grains of water and poured over 2000 grains of barley (which had been previously examined to prove the absence of chlorine). The mixture was carefully heated so as to evaporate the liquid in contact with the barley; the barley was then burnt; it burnt with difficulty on account of the quantity of salt present, and the heat being high, the ash was partly fused. The ash was dissolved in 5000 grains of water and nitric acid. To 2000 grains of this liquid nitrate of silver was added; the chloride of silver weighed 24·61 grains = 6·07 chlorine, or 15·17 on the whole ash.

| | |
|---|---|
| The chlorine in the common salt is . . | 15·93 |
| That found in the ash . . . . | 15·17 |
| Leaving a loss of. . . . . | ·76 grains |

of chlorine in the burning, in circumstances most favourable for the occurrence of such loss.

In other words, supposing in a silicious and highly phosphoric ash 25 per cent. of common salt to be present, analysis would indicate something more than 24 per cent. of this substance; so that in an extreme case the loss of this substance would be practically insignificant. It is plainly *possible* to lose chlorine in the burning of plants; and every tyro knows that the chlorides of potassium and sodium are capable of dissipation at a high temperature. All that it is here wished to assert is, that the burning of plants, if carefully conducted, is not attended with a sensible loss of chlorine, and when this is found to occur, it is more probably due to volatilization of the chlorides than to any other cause.

* The sulphate of potash was added here to make the experiment serve a double purpose.

### *Potash and Soda.*

The arguments and experiments which apply to chlorine apply also to these ingredients of plant-ashes, which could only be lost in the form of chlorides.

The chlorides of potassium and sodium (especially the first) are volatile at very high temperatures, but they may be heated to dull redness with perfect security, as is done every day in the separation and estimation of these alkalies. We have shown that at a temperature adequate to the burning of the most troublesome vegetable no appreciable amount of chlorine is lost, and under the same circumstances, therefore, no loss of the alkalies is to be feared.

It is, after all, a matter of temperature, and the discrepancies in the results obtained by different ash analysts may, no doubt, in many cases be referrible to this cause. The burning of a plant for analysis is plainly a process requiring considerable care —a process that should in no instance be hurried forward;—but we think that, on the whole, we have demonstrated that (with the exception of the sulphur, which is obtained by a separate process) our method of burning crops affords an ash really and correctly representing the mineral matter of the plants under investigation.

It only now remains that the method of *analysing* the ash so prepared should be shortly adverted to. In the last Report on plant-ashes a short notice of the methods of analysis was inserted, and we shall in this place notice the only particular upon which any doubt could possibly arise, namely, the estimation of the phosphoric acid. The processes employed in the estimation of the other constituents are those in common use amongst chemists, and universally allowed to be accurate.

In the estimation of phosphoric acid a *measured* quantity of iron solution is employed. It is sometimes thought that a sufficient amount of accuracy cannot be ensured by this measuring of the test solution, in which a long delicately graduated measure capable of containing 1000 grains of liquid is employed. The following trials were made of different quantities of the same iron solution, the oxide of iron being precipitated by ammonia, burnt, and weighed:—

| | | | Oxide of Iron. | | Grains in 1000 of liquid. |
|---|---|---|---|---|---|
| 1st exp. | 660·0 | measures gave | 2·140 | = | 3·242 |
| 2nd ,, | 972·0 | ,, | 3·150 | = | 3·241 |
| 3rd ,, | 24·4 | ,, | ·790 | = | 3·238 |

These experiments were made by one of us. The following are results of the measurement of the same iron liquids by the other author of this paper:—

| | | | Oxide of Iron. | | Grains in 1000 of liquid. |
|---|---|---|---|---|---|
| 1st exp. | 87·5 | measures gave | 2·83 | = | 3·230 |
| 2nd ,, | 48·5 | ,, | 1·56 | = | 3·216 |
| 3rd ,, | 28·5 | ,, | 1·55 | = | 3·207 |

It will be seen that a slight difference exists in the results obtained by the two operators, but that the numbers in each series are almost identical. It is unnecessary to say that this is due to trifling variation in the method of reading off the quantities, and in no way affects the accuracy of analyses so performed. In proof of the accuracy of the estimation of phosphoric acid by the addition of iron, we must refer to the different experiments quoted before, more especially to the series of white peas and white mustard-seed, which were analysed in this way. It is inconceivable that these results should be so nearly alike, were there anything radically defective in the process of estimating the phosphoric acid. We have latterly, however, found it more convenient to adopt another system for the estimation of phosphoric acid, which is as follows:—

The solution of the ash in hydrochloric acid is treated as usual with acetate of ammonia, for the separation of the oxide of iron as phosphate. The lime is next thrown down by neutral oxalate of ammonia (acetic acid being the only free acid present); the liquid is then divided into two portions—to one ammonia is added (and, if necessary, phosphate of soda), to precipitate magnesia; and to the other portion sulphate of magnesia and ammonia are added, and the phosphoric acid estimated as phosphate of magnesia.

That this method gives accurate results as respects the lime, phosphoric acid, and magnesia, will, we think, be evident from the following experiment:—

The solution in hydrochloric acid of 10 grains of the ash of white peas was treated with acetate of ammonia, and after the separation of the phosphate of iron a solution of iron was added to precipitate the phosphoric acid; the phosphate of iron so obtained was converted, by Fresenius's process, into phosphate of magnesia, which weighed 5·98 grains, equal to 37·89 per cent. of phosphoric acid in the ash. From the solution to which the iron liquid had been added, the lime was precipitated by oxalate of ammonia and ammonia, yielding 2·18 of carbonate of lime, equal to 6·10 per cent. of lime. The magnesia was then precipitated by phosphate of soda, giving 1·95 of pyrophosphate, equal to 7·14 per cent. of magnesia.

Twenty grains of the same ash dissolved in hydrochloric acid, and the iron separated by acetate of ammonia; oxalate of ammonia added to separate the lime, giving 4·40 of carbonate of

lime, equal to 6·16 per cent. of lime. The liquid divided into two portions; the magnesia thrown down by the addition of ammonia (there being an abundance of phosphoric acid already present) gave 1·92 phosphate of magnesia, equal to 7·03 per cent. of magnesia.

The phosphoric acid separated by the addition of ammonia and of sulphate of magnesia from the other portion of the liquid, yielded 6·05 phosphate of magnesia, equal to 38·31 per cent. phosphoric acid. The results on 100 grains of the ash of peas by these different methods are thus stated:—

| | Lime. | Magnesia. | Phosphoric Acid. |
|---|---|---|---|
| The phosphoric acid, being separated by oxide of iron | 6·10 | 7·14 | 37·89 |
| The phosphoric acid separated after the lime as phosphate of magnesia | 6·16 | 7·03 | 38·31 |

This experiment proves satisfactorily that lime may be entirely precipitated as oxalate in the presence of free acetic acid, and that phosphoric acid will, in the same circumstances, remain in the liquid for subsequent separation.

It is necessary to make a few remarks in reference to the composition of the phosphate of iron which is thrown down in the first stages of plant-ash analysis—that is, when the acid solution of the ash is neutralized by acetate of ammonia. To this phosphate of iron Fresenius ascribes a definite composition, with a percentage of

42·78 peroxide of iron.
57·22 phosphoric acid.

We have been led, however, from several causes to doubt the uniformity of this compound, and to institute some experiments on the subject. If an acid liquid containing a persalt of iron and an alkaline phosphate in excess be neutralized by ammonia, phosphate of iron is thrown down, more or less coloured, and of variable composition. The neutral phosphate of iron is (as is well known) robbed of phosphoric acid by a fixed alkali, such as potash, and reduced to the red-coloured sub-phosphate. The same occurs, although in a less degree, with caustic ammonia, and the yellowish-white phosphate of iron is soon reddened in an ammoniacal liquid. Indeed so unstable is this compound that it will part with phosphoric acid even to some ammoniacal salts: thus if the phosphate of iron when almost colourless be dissolved in hydrochloric acid and re-precipitated by acetate of ammonia, it will be found to have acquired a very decided red tint, and phosphoric acid may be detected in the filtered liquid. This circumstance, it is plain, must materially affect the estimation of oxide of iron, where it is calculated from the amount of phosphate pre-

cipitated by acetate of ammonia. The following experiments are selected from many others as showing that the composition of the phosphate is greatly dependent on the relative quantities of the different re-agents employed in its production. In the first two experiments clean iron wire was dissolved in nitro-hydrochloric acid; the solution was diluted with water, and phosphate of soda added in excess; the phosphate of iron was then precipitated from the acid liquid by excess of acetate of ammonia; the precipitate was burnt and weighed. No care was taken to use *equal quantities* of the different re-agents in the two experiments, and they were consequently unlike in this respect.

| | Grains of Iron. | | Grains of Phosphate. | | Per cent. of Peroxide of Iron. |
|---|---|---|---|---|---|
| 1st exp. | 1·14 | gave | 3·07 | = | 53·09 |
| 2nd ,, | 1·35 | ,, | 3·99 | = | 48·38 |

In this case, then, the results are by no means uniform.

In the two following experiments the *same* quantity of iron was dissolved—equal quantities of acid, of phosphate of soda, and acetate of ammonia being employed in both cases:—

| | Grains of Iron. | | Grains of Phosphate. | | Per cent. of Peroxide of Iron. |
|---|---|---|---|---|---|
| 1st exp. | 0·75 | gave | 2·15 | = | 49·72 |
| 2nd ,, | 0·75 | ,, | 2·17 | = | 49·30 |

Here the results are nearly identical.

Two other experiments in which the quantities of the different substances employed were alike, although different from those in the last experiments, gave the following results:—

| | Grains of Iron. | | Grains of Phosphate. | | Per cent. of Peroxide of Iron. |
|---|---|---|---|---|---|
| 1st exp. | 0·94 | gave | 3·08 | = | 43·50 |
| 2nd ,, | 0·94 | ,, | 2·99 | = | 44·81 |

These two results, although not perfectly identical, are sufficiently so to prove that the composition of phosphate of iron as precipitated by acetate of ammonia from an acid solution in the presence of an excess of an alkaline phosphate, is entirely decided by the accidental relation of the different substances present; for it will be seen that whilst the percentage of oxide of iron is the same under the same circumstances, it is at once altered when these are dissimilar.

The practical bearing of this circumstance in the analysis of plant-ashes is not great, since the quantity of iron present is generally too insignificant to alter in any material respect the proportion of phosphoric acid so obtained. In all cases, however, where much iron is present it is necessary to convert the phosphate of iron into phosphate of magnesia by the process of

Fresenius, and to calculate the oxide of iron from the difference.

The experiments that have been brought forward in this paper will, we trust, be sufficient to establish a well-grounded confidence in the results of our analyses of plant-ashes published in this and former Journals of the Society. We have candidly acknowledged those particulars in which they are open to objection, and feel that our assertion of their general accuracy will, on that account, be more readily received.

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## VII.—*Observations on the Natural History and Economy of various Insects affecting Carrots and Parsnips: including Plant-Lice, the Maggots of Flies, the Caterpillars of Moths, &c.* By JOHN CURTIS, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence; of the Academy of Natural Sciences of Philadelphia, &c.

### PAPER XIV.

As the tap-rooted vegetables are likely to become of more importance in field culture, both as food for cattle and man, an acquaintance with the enemies which assail and injure the carrots and parsnips must not be neglected, for such knowledge is actually necessary to their successful cultivation. As far as my own experience extends I am convinced that the parsnip is one of the best substitutes for the potato, not only as regards its nutritive qualities, but its produce also;* and when a taste for it is once acquired, it becomes a most agreeable culinary vegetable: it is also sufficiently solid to satisfy hunger, and it is gently aperient. The greatest objection appears to me to be the length of time it occupies the ground, as parsnips keep best *in* the earth; but this inconvenience, as far as the cottager is concerned, might be remedied by lifting the roots when full grown, about Christmas, and packing them vertically, close together, in some spare spot, from whence they could be drawn as they were wanted. I am also pretty certain that it is desirable to vary the vegetables which so largely contribute to the support of the labouring classes; for I have strong reasons for believing that potatoes, or any other vegetable, eaten day after day, will not conduce to health and strength as the use of three or four different sorts will alternately: the culture, therefore, of broad and scarlet beans, Jerusalem artichokes, and parsnips, would make a wholesome, agreeable,

* *Vide* Col. Le Couteur's valuable remarks in the 'Royal Agric. Journal,' vol. i. p. 419, and Dickson's 'Practical Agriculture,' vol. ii. p. 718.

and profitable variety in the poor man's bill of fare, in combination with potatoes, greens, turnips, and onions.

Carrots are already so valuable in some counties, that the failure of them is severely felt; yet, with the exception of the turnip, I know of no crop which is more subject to the fatal attacks of the insect tribes in every stage of its growth. As soon as the tap-root is formed, until the period of its being matured, the maggots of a fly, as well as other little animals, including slugs, are constantly diminishing the produce. The young foliage no sooner appears than it is filled with *aphides*, and at a more advanced stage the leaves become an agreeable food for caterpillars; and lastly, the seed-crops are almost annihilated by smaller caterpillars, which devour the flowers as well as the seeds.

### Aphis Dauci, the Carrot-leaf Plant-Louse.*

In the first week of July last year I visited the neighbourhood of Guildford, in Surrey, when Mr. Ellis showed me a field of carrots, which had been a strong plant; but one-tenth of the crop had recently gone off. This malady was indicated by the yellow foliage, and on pulling up the roots they were sound and clean; yet the crowns were not only discoloured, but dead or dying, and on opening the embryo leaves we found concealed at the base from 2 to 7 or 8 green *aphides*. A few days after, Mr. T. Dickinson, of the Guildford Nursery, took me to a bed of carrots which was going off in a similar way. Here, however, the *aphides* were gone, excepting a female, which had been punctured by some parasite; and it was evident they had commenced their operations earlier in the year, for the central leaves were hard and black. In this instance the tap-roots were becoming woody inside, and some of them were throwing out quantities of fibrous roots, like old growing carrots which had been kept through the winter.

1. These *Aphides* were scarcely larger than cheese-mites, of an uniform pale-green colour, with 6 legs, 2 horns, and no wings. I had hoped to have found them at a more advanced stage, when the females were bringing forth young, and some of them might have attained wings, but I did not remain at Guildford long enough, and I could not meet with them in Dorsetshire or in the Isle of Wight.

As soon as a bed is affected by *aphides*, powdered tobacco should be dusted over the crowns of the carrots early in the morning whilst the dew is upon them, or they may be watered with a decoction of tobacco, which is fatal to all Plant-lice. Removing the dying plants is of little use, as the insects remove from them

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* Curtis's 'Guide to an Arrangement of British Insects,' Genus 1047 *b*, No. 39.

as soon as the foliage produces no more sap. Another species of *aphis* is found in October on the roots,* and being of an ochreous or pale yellow colour, it is not easily detected. The only specimens I have seen were small, apterous, and mealy, as such subterranean species generally are. They had 2 short horns and 6 short stoutish legs.

### The Rust.

This disease, which so materially affects the carrot crops and deteriorates their value, is occasioned in the first instance by the larvæ of a small fly. These maggots eat passages in the tap-root, as exhibited in Pl. T, fig. 1, and the carrots gradually die off, changing to an ochraceous or ferruginous colour where they have been eaten, whence they are termed "Rusty" by cultivators, and they become of little value; for the fibrous roots perishing, or being arrested in their growth, from a want of free and healthy circulation, the plants sicken if they do not immediately die: they lose their saccharine qualities, are consequently no longer sweet to the taste, and eventually they become black and rotten, especially when stored. The flies and their maggots are found through the summer, and the latter even in the winter, but they leave the roots to become pupæ in the earth, in which state they remain until the spring, but the summer broods hatch in three or four weeks.

On digging up some carrots in a clay soil the end of December, 1844, which were small and crowded from having been neglected, I found a considerable number of them maggot-eaten or rusty. On the tops were small black slugs; white Poduræ† were also running out and into the cavities, and towards the apex of the roots large excavations were made, as represented in the plate (fig. 1), whether by slugs, worms, or millipedes, I cannot say. The most remarkable appearance, however, was occasioned by whitish, shining, conical objects sticking out of the sides horizontally, sometimes projecting nearly a quarter of an inch (fig. 2, 2). I soon saw they were maggots, which on being exposed to the light often withdrew themselves into the holes they had made in the carrot, and on dividing these longitudinally, various labyrinths were exposed, some of which entered the very heart of the root (fig. 3): these cavities were dirty and brown, which colour was suffused to a considerable extent.

The maggots are ochreous and shining, cylindrical, pointed at the head and obtuse at the tail: they resemble cheese-hoppers,

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* 'Entomologist,' p. 127.

† They are little skipping animals, thus named by Linnæus. *Vide* Curtis's 'Guide,' Genus 4.

but they cannot leap (fig. 4); they are exceedingly transparent, so that every internal part is visible. The head is a black horny substance, which contains the mouth; this is alternately thrust out and contracted with great activity, the tip forming a hook, the base being forked like two spreading black horsehairs; the body is composed of 11 rings besides the head and tail, this being rounded and producing 2 little black horny tubercles (fig. 5); from these extend 2 somewhat parallel pale lines which may be traced to the head; the intestines are also pale, but beneath the antepenultimate segment is a bag of reddish excrement, more of a purple tint than the carrot which it had been feeding upon (fig. 6, magnified).

The pupa is cylindrical, horny, shining, and coppery-ochreous (fig. 7), finely striated in rings, and of a pale rusty colour at the extremities; the head is sloped off very much, forming an oval concave lid, with a thickened margin, which lifts up to allow the fly to crawl out when it hatches, and in front are 2 minute black tubercles; the tail is rounded and furnished with 2 little black points (fig. 8, magnified).

The fly which it produces belongs to the Order Diptera, the Family Muscidæ, the Genus Psila, and was named Rosæ by Fabricius,* being found probably by him sunning itself upon the leaves of rose-bushes, and unfortunately he was unacquainted with its economy.

## Psila Rosæ, the Carrot-Fly.

2. P. Rosæ is shining, of a pitchy black, with a greenish tinge, and clothed with pale hairs (fig. 9); the head (fig. 10) is globose and rusty ochre, with a few bristles; eyes lateral, orbicular, and black after death; on the crown is a black spot with little simple eyes in triangle; the face slopes inward, and the two drooping horns are inserted under the projecting forehead; the 3rd joint is oval and black at the tip, and on the back is inserted a pubescent ochreous bristle (fig. *a*); the trunk is oblong; the scutellum is small, trigonate, and rusty; the 6-jointed abdomen is rather small, oval, and conical at the apex in the female, and furnished with a telescopiform contractile ovipositor (fig. 11); the wings lie horizontally on the back when at rest, and extend beyond the tail, being ample, iridescent, with a yellowish tinge, and all the nervures are bright ochreous; the poisers are small and whitish; the legs are bright ochreous, and pubescent; the feet are 5-jointed, the basal joint very long, the 5th small, with 2 little black

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* 'Entomologia Systematica,' vol. iv. p. 356, No. 181. Curtis's 'Guide,' Genus 1303, No. 5.

claws and 2 small cushions or pulvilli: it is 3 lines long, and the wings expand 5 lines.

I am disposed to think that I have bred a closely-allied species from similar larvæ in the carrot roots, but the flies were so mutilated before I discovered them, that I cannot be certain; it seems, however, more than probable, because *Psila Rosæ* I have never found in my garden, whilst the species I allude to (*P. nigricornis*) is abundant there.

3. Psila nigricornis of Meigen* is very like *P. Rosæ*, but rather smaller, and the 3rd oval joint of the horns is entirely black. I think it far from improbable that it may be only a variety of that insect.

It is not always the mature crops which suffer from these maggots, for some young carrot roots, sent to me the first week in July, 1845, from Castel Connel, in Ireland, were drilled through by them, as shown at fig. 12; and previously, in 1842, young crops were similarly affected, but the maggots were not discovered where the spots existed, owing probably at that time to the minuteness of the recently produced larvæ.

With a view of rescuing the carrot crops from this pest, it has been recommended that as soon as the outer leaves become yellow and wither, which are indications that the root has been infested, such plants should be taken up without delay, and the grubs destroyed by immersing the roots in hot water.

If land be left, as allotments often are, to remain through the winter just as the crops have been drawn, not only that plot of ground, but the whole neighbourhood, may be deluged with noxious and troublesome insects: whereas, by trenching in the autumn, the pupæ of these and other flies are not only subjected to frost, snow, and rain, as well as extreme transitions of temperature, but the inhabitants of the soil are exposed to the prying eye of the robin and various birds, which subsist to a great extent upon insects and seeds during the winter.

Before sowing carrots, it is a great security against the Rust to give a dressing of spirits of tar and sand. It is even reported that pigeons' dung or cow-dung, pointed in at the time of sowing, will secure the crop from these maggots. Old turf well incorporated with quick-lime, at the rate of 80 loads per acre, on a light soil, produced a fine crop entirely free from insects.† If quick-lime alone be sown over the surface, let it lie two or three days and repeat the operation, after which it is to be ploughed in: this will free the soil from insects and slugs which prey upon the

* 'Systematische Beschr. Europ. zweif. Inseckten,' vol. v. p. 359.
† 'Caledonian Hort. Soc.,' vol. vi. p. 2.

carrot crops, but of course the drier the weather is the better the lime will take effect.*

The spirit of tar, however, has been so often successfully tried, and it is so applicable to field culture, that I shall give the best directions I am able to obtain for its use. Take a barrowful of sand and pour a gallon of spirits of tar upon it by degrees, so as thoroughly to incorporate the whole mass, with the hands, then sow it over the surface of the field intended for carrots. The above quantity will be enough for 60 or 70 square yards. The object of uniting the spirits of tar with the sand is to divide it so minutely that a small quantity may be scattered over a large space; for it is believed that the scent is so offensive to insects, they cannot endure the soil where it is thus employed: under these circumstances the female flies would avoid such localities, and in all probability the spirits of tar would kill the young larvæ if even they hatched. Some cultivators have applied this dressing in the autumn, digging it in and letting it remain until the carrots were sown, whilst others have tried it after the sowing in April; and I have heard of its being sown at the same time as the seed, with equally good effect.† When it is dug or ploughed in during the autumn, it is supposed to drive the vermin to the surface, where they perish; and if repeated in the spring, after sowing, it no doubt renders the surface disagreeable to the flies, as I have already stated.

In the cage where I bred the *Psila* I found also a species of *Alysia*, somewhat allied to the *A. Apii*,‡ which I can only presume was a parasite connected with its economy, as it might have been introduced with the soil.

## Millipedes and Centipedes.

The *Polydesmus complanatus* is attracted to the roots which have been previously perforated by the maggots of the *Psila*, and sometimes congregates in such vast numbers, that I suppose it was this little animal which was reported to have devoured carrots by the acre in Scotland in 1831; but as its characters with figures have already been published in this Journal, it is unnecessary to give any further description of it here.§ It may, however, be added that these Millipedes are said to crawl about the surface before sunrise, when they have been collected into cans by myriads and destroyed.|| A Centipede, named *Scolopendra elec-*

* 'Gardener's Mag.,' vol. xvi. p. 208.
† 'Gardener's Chron.,' vol. ii. pp. 365, 726, and 821. Vol. iii. pp. 5 and 86.
‡ *Vide* p. 192.
§ *Vide* vol. v. p. 230, pl. J. f. 55.
|| 'Scotsma n,' forMay 14, 1831.

*trica,* often accompanies the *Polydesmus,* and assists in such depredations.

### The Otter Caterpillar.

On cutting through a carrot in January last, which was black and decayed inside, I was very much suprised to find a cavity 2 or 3 inches long, and within a large white caterpillar, which unfortunately was so injured by the knife that it died. It was, however, unquestionably the larva of a Ghost-Moth, named *Hepialus humili.** It was evidently preparing to change to a pupa, for it had cast its skin, which was pushed to the bottom of the cell, and a loose web was spun across the top. This fact shows that the Otter Caterpillar will feed upon roots very different in their nature from those of the hop. I must pass over the economy of this destructive insect for the present, as its history is more immediately connected with the Hop-gardens.

We will now leave the roots of the carrot, and proceed to investigate the injuries sustained by the foliage, flowers, and seeds, as they are successively developed.

### Papilio Machaon, the Swallow-tailed Butterfly.

This is the first to be noticed; but it is an insect so far from common, being entirely confined to certain localities in this country, that it is rather with a view of completing the history of the Carrot insects, than from any necessity of guarding the agriculturist against its inroads, that it is introduced. It is, however, abundant in France, where the graceful evolutions of the Swallow-tailed Butterflies may sometimes be seen even in the gardens of towns. As England is being better drained, many native insects are expelled from their ancient haunts, and are becoming extinct in some districts: this is the case with *Papilio Machaon,* whose geographical range has been greatly circumscribed by cultivation within a comparatively short period. Some forty years back this conspicuous butterfly appeared annually in neighbourhoods where now it is never seen. My friend Mr. Dale, of Glanville's Wootton, used to observe it annually sailing around his property in Dorsetshire, where now it may be searched for in vain, although the same hills, pastures, and plantations remain pretty nearly as they were at the time alluded to: it was also formerly abundant at Westerham, in Kent, and around London; but at present, if any one wishes to find this beautiful butterfly he must go to the fens of Cambridgeshire, Huntingdonshire, or Norfolk, where, at Burwell, Whittlesea, and Horning, 30 or 40 may be taken in a fine day from May to midsummer.

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* Curtis's 'Brit. Ent.,' fol. 185. 'Guide,' Genus 791, No. 1.

The female butterfly will lay her eggs indiscriminately upon the leaves and flowers of carrots, the marsh milk-parsley (*Selinum palustre*), rue or fennel, the end of May and in June. The caterpillars of various sizes and colours may be found feeding in June and July; and the butterfly is sometimes seen until the middle of August.

The caterpillars are black when first hatched, which colour they retain until they are half grown, being then ornamented with spots and rings of green, with warts producing minute brushes of bristles: when arrived at maturity they are nearly two inches long and as thick as a swan's quill; they are then beautiful objects, being quite smooth, of a charming green colour, with black velvety rings, upon which are orange warts, excepting the alternate rings, which form a junction with the segments, and are often concealed when at rest. They have 6 black pectoral legs like horny claws, 8 fleshy abdominal feet, and 2 similar anal ones for holding firmly; but the most curious distinction in the structure is a forked apparatus, like a Y, of an orange colour, inserted behind the horny head, which the animal can thrust out or withdraw at pleasure; and this organ, which secretes an acrid fluid of an offensive scent, is believed to drive away the *Ichneumons* and other parasitic enemies, which would otherwise annihilate such a conspicuous species. It is generally in July that the transformation to the chrysalis takes place, when the caterpillar fastens its tail, spins a thread across its back, shoots off its skin, and assumes a yellow or green tint, with an interrupted black stripe on each side.

The butterfly is the largest and finest species produced in this country, belonging to the ORDER LEPIDOPTERA, the FAMILY PAPILIONIDÆ, the GENUS PAPILIO,* and it was named by Linnæus,

4. *Papilio Machaon*, and is called the Swallow-tailed Butterfly, from the two appendages which emanate from the hinder wings. It is yellow with black horns: the head, trunk, and body are black, the sides striped with yellow: the upper wings have a large black space at the base freckled with yellow, the hinder margin is black with a line of yellow crescents; the nervures form black stripes, and there are 3 largish black patches above the disc: the lower wings have a broad black border with yellow crescents along the margin, and there are 6 freckled blue patches upon the back, with a brick-red eye-like spot at the anal angle, and a blue crescent above, the whole enclosed in a black ring; the tails are black with a yellow edge inside: the wings expand from 3 to $3\frac{1}{2}$ inches.

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* Curtis's 'Brit. Ent.,' fol. and pl. 578, where another species is figured, called *P. Podalirius*, which seems to have deserted our island.

Carrot and parsnip crops when left for seed are dreadfully injured by multitudes of rather small caterpillars, which roll up the leaves, spinning webs amongst the flowers and capsules, to enable them to feed in security, leaving nothing but the stalks and fragments of the fructification to reward the owner. This is so great a loss that it is well worth attending to, and by becoming acquainted with the habits of these insects, no doubt their ravages may be arrested.

They all belong to the ORDER LEPIDOPTERA, the FAMILY TINEIDÆ, and the GENUS DEPRESSARIA of English authors, but in Germany and France they are generally described under the generic term *Hæmilis*. One species is named

DEPRESSARIA CICUTELLA, the common flat-body Moth,

a vulgar name which it has received from its depressed abdomen, to which also the Latin generic name alludes, and the scientific specific one is no doubt applied from its inhabiting a cowbane named *Cicuta*, one species, *C. virosa*, being a very abundant plant in our ditches: the caterpillars are also found upon the wild chervil (*Chærophyllum sylvestre*) and gout-weed (*Ægopodium podagraria*), weeds equally abundant in our hedges. These are all *Umbelliferæ* as well as the carrot (*Daucus Carota*), about which the moths are usually seen flying to extract honey from the flowers. The common flat-body moths seem to be domestic species, for they enter our houses and are often mistaken for clothes-moths, from their frequenting rooms which are seldom used, and are seen upon the curtains, walls, and windows of our sleeping-rooms in the evening. They endeavour to avoid the light, running about with much activity, and gliding over the surface until they can find a quiet corner to conceal themselves in. They also fly well and rapidly; and the females, which live through the winter, lay their eggs upon the flower-heads, or umbels as they are called, or in the axilla of the leaves, for in June the caterpillars are large enough to be discovered, and immediately cut the leaves of the chervil or carrot to bend and form them into little tunnels, which are held together by threads; in these they reside, feeding as it were upon the walls of their habitation, and when these are consumed they remove to another leaf, which is rolled up in the same way. Each end is left open to allow the caterpillars, when they are alarmed or disturbed, to fall to the ground by a thread proceeding from the mouth. This is necessary to enable them to escape from their natural enemies, amongst which are the Solitary-wasps (*Odyneri*),* which fill

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* Curtis's 'Brit. Ent.,' fol. and pl. 137.

their cells with this kind of caterpillar to support their young. They are exceedingly active, wriggling backward and forward, and jumping from one side to another, when touched, as if in convulsions: they are ½ an inch long, of a grass-green colour, with a darker green line down either side and one along the back; on each segment are 10 warty black points, 4 disposed in a quadrangle on the back and 3 obliquely on each side: the head is brown with 2 brighter spots of the same colour; the thoracic scale is brown with a broad black margin, and they have 16 green legs.

When they are ready to change to pupæ they become rosy beneath, very restless, and continually wander about as if seeking for food. Sometimes it appears they enter the earth to change to pupæ,* where they form little oval cocoons of grains of sand, loosely attached by silken threads, the inside being lined with silk, or they undergo their transformations in the habitation formed in the leaf.† The chrysalides are of a deep yellow-brown and shining. There are two broods annually; the June one hatches in August, and the caterpillars found the first week in September become moths the end of October, and they hybernate.

5. *D. Cicutella* is supposed also to be the *Pyralis applana* of Fabricius. It is of a dull pale reddish-ochre colour, and shines like satin: the eyes are small, black, and orbicular; the horns are long and slender, and the palpi, or feelers, are curved upward like short scaly horns, but the apex appears naked and pointed: the trunk is orbicular, the body depressed, the tail tufted with ochreous hairs in the male, lanceolate in the female: the wings rest flat upon the back in repose, one lying over the other (fig. 13): the upper wings are long and narrow, freckled with brown and black, forming indistinct spots upon the pinion edge, along which is a light streak, on the disc are 3 white dots with dark edges, and 2 brown dots nearer the base: the under wings are yellowish-grey, very satiny, with a longish fringe: fig. 14, magnified, the expanse of the wings being 10 lines.

### DEPRESSARIA DEPRESSELLA, the purple Carrot and Parsnip-seed flat-body Moth.

A variety was figured under that name by Hubner,‡ in which the pale marks on the upper wings were entirely wanting, and this led me to publish it under another appellation.§ This species is less generally distributed than *D. Cicutella*, yet it is abundant

* De Geer's 'Hist. des Ins.,' vol. i. p. 424.
† Godart's 'Lep. de France,' vol. xi. p. 129, pl. 290, f. 4.
‡ 'Samlung Europ. Schmet. Tinea,' pl. 61, f. 407.
§ D. Bluntii: Curt. 'Brit. Ent.,' fol. and pl. 221.

enough in some districts. It is, I believe, confined to the more northern latitudes, being very common in Bohemia and around Berlin, as we learn from M. Fischer de Röslerstamm, who remarks, "It is astonishing that this species, so injurious to kitchen-garden plants, should be so little known and in so few collections, for M. Bouché of Berlin finds it by thousands."* It also inhabits the wild parsnip (*Pastinaca sativa*), along the shores of the Thames, especially around Southend, where it was found and bred from the caterpillar by the late Mr. E. Blunt and Mr. C. Parsons; but I have never seen the larvæ, which feed in society in July and August upon the flowers and capsules of the carrot and parsnip. There they also change to pupæ in a light grey web. In the autumn the habits of the caterpillars are somewhat altered, for they eat into the stalks to winter there and undergo their transformations. Early in the spring, or even at the end of winter, if mild weather prevails, the moths hatch, come out of the hole in the stalk, previously made by the entrance of the larva, and fly about, but on the return of cold or bad weather they shelter themselves in holes, thatch, outhouses, under loose bark, in chinks of trees and paling, under stones, &c.

6. *Depressaria depressella* varies in the size of the sexes: the *male* only expands 6 lines (fig. 15): it is of a yellowish mouse-colour and silky; the horns are not long; the round eyes and tips of the recurved palpi are black, the latter are ochreous at the base; the head and thorax are also ochreous; the tail is blunt; the upper wings are of a chestnut colour with pale ochreous scales on the disc, more or less visible, sometimes wanting, at others forming patches. The wings of the Female expand 8 or 9 lines and are similar in colour to the male, but the upper ones are generally brighter chestnut, and the whitish scales unite and form a somewhat irregular oval mark, open at the top; the tail is pointed (fig. 16, magnified).

Although the caterpillars of this species are very abundant on carrot-seeds, they prefer the parsnip, which has induced gardeners to set parsnips amongst carrots left for seed, in order to attract the moths to them, so that the caterpillars may be more readily collected and destroyed. Bouché has never observed this species upon the common cow parsnip (*Heracleum Sphondylium*), which is a favourite resort of some species. It may be advisable to add his description of the caterpillar, which resembles that of *D. Daucella*, but it is much smaller: the ground-colour is pale brownish-grey; it is rough with black spines producing single hairs; the hairs have large white basal warts, which are arranged like those of *D. Daucella*: sides of the body with inflated edges:

* Godart, 'Lep. de France,' vol. xi. p. 140.

spiracles black: head, thoracic plate, and pectoral feet deep black; abdominal feet having the soles furnished with a ring of hooks: length $3\frac{1}{2}$ lines.

DEPRESSARIA DAUCELLA, the grey Carrot-blossom flat-body Moth.

This is a third species of the same genus of Moths whose caterpillars consume the flowers and seeds of the carrots and parsnips in July and August, causing great damage and sometimes destroying the entire crop; each caterpillar taking possession of an umbel of flowers, which it draws together in the centre by the fine threads that are spun from the mouth (fig. 17); in the midst of this resides the active wriggling caterpillar (fig. 18), which is at least half an inch long when full grown, of a greenish-grey colour inclining to yellow, with minute black warts, emitting short hairs scattered over the segments: there are also indistinct longitudinal streaks down the back; the horny head and back of the first thoracic segment are brown or black. Some change to pupæ amongst the web and stalks of the umbel, whilst others (the later broods probably) bore into the stems to undergo their metamorphoses. The pupa is dull brown with pitchy limb-sheaths, very finely punctured (fig. 19).

7. The Moth, named *D. Daucella*, after the carrot, is ashy-grey: the horns are like slender threads: the palpi or feelers are curved upward: the head and thorax are reddish-brown, freckled with black: the upper wings are also reddish-brown with white atoms scattered over them, and black interrupted lines forming streaks and dots along the nervures, especially towards the hinder margin; the under-side of the upper wings is dark; the under wings are light-grey: it expands 10 or 11 lines.*

This species does not appear to be frequent in England, but it has been observed on the chalky soil of Kent, in Devonshire, and different localities around London.

There are several modes of arresting the mischief which all the caterpillars of these moths occasion. We have stated that the larvæ are very sensitive and fall down by a thread when disturbed: if therefore the flower and seed-heads were shaken over a sieve, with a piece of paper at the bottom to prevent their escaping through the apertures, garden-crops at least might be freed from them. I expect also if powdered hellebore were dusted over the umbels, when the dew is upon the plants, that it would compel the caterpillars to desert their quarters, and it would be worth while to try lime and soot also.

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* Tinea Apiella, Hüb. 'Schmet. Tineæ,' pl. 14, f. 94. Bouché, 'Nat. der Ins.,' p. 124.

The best process, however, for banishing the *D. Daucella*, which is perhaps the most mischievous species, has been suggested to M. Bouché from a knowledge of its economy. He has ascertained that the moths prefer laying their eggs upon the *parsnip*; he therefore plants in his carrot-fields parsnips at 6, 8, or 10 feet asunder, which attract the moths; the eggs are consequently deposited upon them, and the caterpillars will not abandon the umbels on which they were hatched for those of the carrot. By this simple measure he finds, at the time for gathering the carrot seed, that it is not only preserved from the attacks of the caterpillars, but also, being all attached to the parsnip heads, by collecting and burning them these troublesome little pests may be nearly eradicated. He justly observes that this operation must be cautiously performed, otherwise the lively caterpillars will fall out and escape; to prevent this, on approaching the parsnip plant, the infested heads should be instantly bent over a sieve or tub and cut off, so that the contents may be burnt without loss of time; or he proposes that the parsnips might be left until the caterpillars were changed to chrysalides; but this would be a dangerous delay, if any of them descend and enter the earth to undergo their transformations. If they all become pupæ in the umbels or stalks, the proposition is a good one, but such, I am pretty certain, is not invariably the case.

These caterpillars are not free from parasitic enemies; indeed two have been bred from those of *Depressaria Daucella* by Bouché.* They both belong to the ORDER HYMENOPTERA and FAMILY ICHNEUMONIDÆ: the first is comprised in the GENUS CRYPTUS or PHYGADEUON, and was named by Fabricius.

8. Cryptus (Phygadeuon) profligator.† It is black; the abdomen oval, red; petiole narrow and black: legs stout, shanks and thighs red, apex of the hinder thighs black in the male: horns of female with a white ring: 4 wings, transparent or slightly smoked, stigma rusty; areolet 5-sided: abdomen dilated towards the apex in the female; ovipositor $\frac{1}{3}$ or $\frac{1}{4}$ as long as the body: length from 2 to $3\frac{1}{2}$ lines.

This *Ichneumon* is found on umbelliferous flowers, and the female deposits her eggs in a great number of the caterpillars of *Depressaria Daucella*. The 2nd parasite has been named

9. Ophion (Pristomerus) vulnerator by *Gravenhorst*.‡ It is black with the middle of the body red: anterior legs red, black at the base, hinder red and black alternately; the thighs with a tooth

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* 'Garten Inseckten,' pp. 151 and 155.

† Gravenhorst, 'Ichn. Europ.,' vol. ii. p. 729, No. 203. Curtis's 'Guide,' Genus 500, No. 203.

‡ 'Ichn. Europ.,' vol. iii. p. 724, No. 149, Pachymerus vulnerator—Curtis's 'Brit. Ent.,' fol. and pl. 624; 'Guide,' Genus 535a, No. 149.

beneath: ovipositor black; oviduct chestnut-colour, scarcely so long as the body: length 2 to $3\frac{1}{2}$ lines.

This parasite is also often concealed in its maggot state in the caterpillars of *D. Daucella* and other kindred species: both sexes frequent the parsnip when in flower, the beginning of July, and have been taken in the market-gardens round London.

I am not aware whether the caterpillars of the *Depressariæ* ever do much mischief in England, but if they have not yet been abundant, it is in all probability owing to the comparatively small quantity of carrot and parsnip seeds grown in this country, and this will be no security against their appearance at some future period; for owing to the rapid intercourse between distant countries, from peculiar atmospheric changes, and from unknown causes, certain species of insects appear and disappear in almost a mysterious way; but it is incontrovertible that if a vegetable be cultivated to any extent in the open ground, its enemies will not be long before they come to claim their portion (not unfrequently the lion's share) of the produce. As these subjects are more generally studied and better understood, their importance and value will become more evident. Even the remedies suggested and the hints thrown out, if they be not immediately acted upon, may some day fall on good ground and bring forth fruit abundantly to the advantage of the farmer and the public.

The vast per centage of our vegetable produce which is consumed, not by man, but by insects, those almost unobserved visitors—is really incredible. In a wild state of nature their services are most important in reducing the superabundance of rank vegetation; they are not only the scavengers, but the labourers, whose unceasing industry thins the crops and keeps trees, shrubs, and flowers from smothering one another with their luxuriance: at the same time they are manuring the soil and rendering it more productive and more speedily applicable to the wants of the human species: but when the soil is subjected to the skill and industry of man and the produce is to be the reward of his anxiety and labour, the farmer and gardener consider naturally enough, that the services of a great many insects might be dispensed with, advantageously to themselves and no doubt with benefit to the public.

Before attempting to wrestle with such insidious enemies three things are most essential—knowledge, industry, and perseverance. Wanting the first, we may do more harm than good, by destroying our friends instead of our enemies: without industry, the economy of insects can never be attained; and if we have not a great share of perseverance, the best conceived remedies may prove futile. "Practice with Science" in every department of agriculture must lead to useful results; and I trust amongst others, that the science

of Entomology, especially that branch of it which embraces the natural history of insects, will not be neglected by the agriculturist, who has the best means in his power for furnishing men of science with the materials wanted, to dispel erroneous notions and clear up doubts, as well as placing them in a better position to assist the farmer in saving his crops, when they are threatened by those powerful armies, often composed of atoms, it is true, but whose combined force is sometimes irresistible.*

### CALLIMOME DAUCI, the Carrot Gall-fly.

When the carrots are in full flower, the umbels often appear distorted, and on examination one finds a number of small vegetable galls that are produced, it may be presumed, by the punctures of some *Cynips* or *Cecidomyia* when the eggs are laid. It is a very singular fact, but there are a few groups of flies which have the power of causing a derangement in the sap-vessels and an extravasation of the fluids, giving rise to excrescences assuming the most remarkable figures. The greatest number are formed upon the oak, one of them being the Gall of Commerce; others are the oak-apples, and the bedeguar, or moss-like balls upon the stems of dog-roses, which must be known to everybody. These are all the creations of different species of *Cynipes*,† but a beautiful little fly of the same genus as the carrot gall-fly is also produced from them, which is no doubt a parasite. The female *Callimome* is furnished with a slender oviduct as long or longer than the body; this she insinuates through the cuticle of the plant, to deposit her eggs in the maggots of the *Cynips*, which reside in the centre of the galls, where they undergo their transformation to pupæ, and subsequently the flies are hatched and emerge from a hole in the gall, excepting those which are inoculated by the *Callimome;* and it is very singular, but from the galls of the carrot I never bred any other species, and consequently the *Cynips* or *Cecidomyia* ‡ which by analogy ought to produce the galls, is unknown to me at present. I first observed the carrot-galls in the Isle of Wight, about the middle of August, upon the umbels of the wild carrot. On opening the galls, they contained little maggots of a bright orange colour, from which I bred a great number of both sexes of *C. Dauci* the following September.

* Dr. Barton, as quoted by Dr. Asa Fitch, in his recent admirable 'Essay on the Hessian Fly,' says that this little pest has been more destructive "than would be an army of 20,000 Hessians," who were believed to have introduced this dreadful scourge into the United States, with the straw they carried over with them.

† Curtis's 'Brit. Ent.,' fol. and pl. 688. 'Guide,' Genus 564.

‡ The same Genus as the Wheat-Midge.—'Royal Agr. Journal,' vol. vi. p. 139.

These beautiful flies belong to the ORDER HYMENOPTERA, the FAMILY CHALCIDIDÆ, the GENUS CALLIMOME; and the SPECIES immediately connected with this subject was named by me

10. C. Dauci, from its being bred from the carrot.* The *male* is of a brilliant metallic green; the horns are 13-jointed and black, basal joint green; the head is short and broad, thickly punctured; the compound eyes are lateral and orbicular, the simple ones form a broad triangle on the crown; the thorax is oval and punctured, the sections deeply marked: the abdomen is smaller than the thorax, somewhat spindle-shaped, very glossy, scooped out at the base, the apex with a short horny process: the 4 wings are as transparent as glass, but iridescent; the superior have an ochreous nervure along the costa, which terminates beyond the middle in a little dot: the legs are straw-colour, the coxæ and thighs are metallic green, the apex of the latter ochreous; hinder shanks pitchy, excepting the base and apex; feet 5-jointed, tips black, terminated by minute claws and cushions: length $1\frac{1}{4}$ line, expanse $2\frac{1}{2}$ (fig. 20). *Female* larger; $1\frac{1}{2}$ line long, ovipositor $\frac{3}{4}$ line long (fig. 21, magnified): bright-green like the male: the horns are also black, but the long basal joint is straw-colour with a dark streak on the back: the abdomen is not concave at the base, and it is terminated by a long ovipositor composed of an oviduct enclosed between 2 black hairy sheaths: the legs are coloured like those of the male.

*Callimome Dauci* is sometimes considered the same as Olivier's *Cynips auratus*,† and it is also stated to be the *Torymus muscarum* of Nees,‡ but my specimens do not agree with their descriptions, and the economy of them is totally different.

It would scarcely be possible to eradicate these insects without destroying the seed-crop, and as it is almost certain that they are the destined check upon some *Cynips* or *Cecidomyia* which first creates the galls, by burning the infected umbels our friends would fall victims to such a measure, as well as the actual offenders.

### TEPHRITIS SOLSTITIALIS.

This beautiful fly is abundant on thistle blossoms during the summer, and being named by Fabricius *T. Dauci*,§ which implies that he had reasons for believing that it was connected with the carrot-crops, I cannot pass it by unnoticed, although I am unable to illustrate its history further than to state that *T. cuspidata* of

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* Curtis's 'Brit. Ent.,' fol. 552. 'Guide,' Genus 646.
† 'Encyclopédie Méthodique,' vol. v. p. 781.
‡ 'Hymen. Ichn. Affin.,' vol. ii. p. 58.
§ 'Entom. Syst.,' vol. iv. p. 358.

Meigen,* which is, I think, correctly considered as a variety only of *T. Dauci*, breeds in the cells of the flower-heads of thistles.

This Dipterous fly was named by Linnæus †

11. T. solstitialis. Its head and horns are reddish-ochre; eyes green; thorax olive-green; scutellum yellow; abdomen black, with a long black horny oviduct in the female; wings with 2 or 3 smoky bars, and the apex is margined with the same; legs ochreous: length of male, $1\frac{3}{4}$ line; of female, 3 lines.

Parsnip-roots do not seem to suffer any very material injury from the insects which attack them and their allied neighbour the carrot, and they may be grown successfully upon a heavier soil. Parsnips certainly get rusty in the spring, and even in January I have detected the larvæ of *Psila Rosæ* in them, which is already described as so destructive to carrots, but the inroads of these larvæ do not destroy the flavour of the parsnip, as they do of the carrot: neither do parsnips fall a sacrifice to the *aphides*, nor are the young plants carried off by wireworms, caterpillars, or the maggots of the crane-fly (*Tipula oleracea*).‡ The leaves are frequently blistered by the same insect which infests celery-leaves, and I shall therefore proceed to its history.

### Tephritis Onopordinis; the Parsnip and Celery miner.

*Tephritis* is a group of lively flies, which delight in the sunshine, when they run fluttering over bright leaves, vibrating their beautifully spotted wings, which are carried erect, somewhat like those of the butterflies. About 50 species inhabit this country,§ but with the exception of *T. Onopordinis,* another named *T. Artemisiæ,* whose maggots mine the leaves of the garden chrysanthemums, and possibly *T. solstitialis,* alluded to on the preceding page, there are none that are guilty of any injury to cultivated plants, I believe. A great number of them infest thistles and other Syngenesiæ.

*T. Onopordinis* I have bred as early as March; but from the middle of May to the end of July, the flies may be seen in sunny days in gardens, hedges, at the skirts of woods, or wherever such flowers grow as are an agreeable resort for the males. The female runs over the leaves of the celery and parsnip, and with her telescopiform oviduct she no doubt pierces the cuticle and deposits her eggs, apparently singly; these hatch and produce little transparent maggots, which feed upon the parenchyma, or

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* 'Syst. Besch. Europ. Ins.,' vol. v. p. 328.

† 'Fauna Suecica,' No. 1879.

‡ Journal of Roy. Agr. Soc., vol. viii. p. 413. 'Gardener's Chron.,' vol. i. p. 612.

§ Curtis's 'Brit. Ent.,' fol. and pl. 241. 'Guide,' Genus 1300.

pulp of the leaf, causing large blisters upon them; and when two or three larvæ are feeding on the same leaf, the blisters unite and form large discoloured patches (fig. 22), for the inflated skin, which at first is pale or whitish, as it dries becomes yellow or tawny, and the maggot may be distinctly seen when the leaf is held up to the light (fig. 23). Thus the leaves are disfigured from Midsummer to near Christmas, and as the maggots arrive at maturity, they either change to pupæ in the blisters amongst the excrement of the larvæ, or pierce the skin, and falling upon the earth undergo their transformations in the soil, and from these the flies are again produced.

These two-winged flies belong to the ORDER DIPTERA, the FAMILY MUSCIDÆ, and the GENUS TEPHRITIS: the species was named by Fabricius *

*T. Onopordinis,* from its frequenting the cotton-thistle (*Onopordum Acanthium*). It varies in the spots of the wings, which has led the same author to describe a variety under the name of *T. Centaureæ,* from its resorting to another genus of composite flowers. The eggs I have never seen, but the larvæ (fig. 24) are nearly 4 lines long, shining pale green; they look fat and somewhat transparent, so that the alimentary canal is visible along the back, forming a darker line (fig. 25, magnified): it is attenuated to the head, which is pointed, and the tail is blunt and tubercled; the body is divided into segments, and the sides are wrinkled. The chrysalis (fig. 26, f. 27, magnified) is horny, pale-yellow, glossy, and oval; the segments deeply impressed from the contracting of the maggot, of which this is only the indurated skin, for maggots do not cast their skins as caterpillars do. When one of the pupæ was opened in February, a delicate nymph of a beautiful green colour was seen inside; and when the fly is perfectly matured, it elongates its body, which is filled with a thick cream-like fluid or meconium; the pupa-case cracks at the head and through the opening the fly walks forth.

12. T. Onopordinis. The *Male* is about 2 lines long, and the wings expand 5 or 6 lines: it is shining, tawny, with a few black bristles scattered over the head and thorax: the lower part of the face and the 2 little drooping horns are yellowish; the latter are 3-jointed, with a black bristle ochreous at the base, attached to the back of the 3rd joint, which is oval; at the lower part of the face is a large cavity to receive the mouth, which is composed of a fleshy hairy bilobed lip, 2 long hairy fleshy feelers, and a short strong horny pointed tongue;† the lateral compound eyes are remote, ovate, and deep green, and there are 3 little simple eyes

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* 'Entom. Syst.,' vol. iv. p. 360. Trypeta, Meig., vol. v. p. 316.
† *Vide* Curtis's 'Brit. Ent.,' pl. 241, for dissections.

forming a triangle on the crown upon a dark spot: trunk ovate, the scutel semi-ovate: abdomen somewhat oval; wings ample, iridescent, transparent, variegated with brown, forming spots of various sizes; poisers small, clavate, and ochreous: legs 6, ochreous with short black hairs; feet 5-jointed, terminated by 2 small claws and 2 lobes or pulvilli between them. *Female* larger, abdomen broader, with a longish retractile ovipositor (fig. 28, f. 29, magnified). In some varieties the trunk and abdomen are pitchy.

Securely as the maggots of these flies mine beneath the surface of the leaves, there are two little parasites which fly and run about to detect them in their habitations, and by depositing their eggs in them they arrest the multiplication of the *Tephrites* to a considerable amount.

They both belong to the ORDER HYMENOPTERA, but one is of the FAMILY ICHNEUMONES ADSCITI: it is included in an extensive GENUS called ALYSIA;* and from its having been produced in the first instance from blistered celery leaves (*Apium graveolens*), I named the species

13. A. Apii. It is pitchy-black and shining; 1½ line long, the wings expand 4 lines: the horns are like slender pilose threads, longer than the whole body, and composed of a multitude of little joints; the 1st joint rust-coloured beneath, the little 2nd joint entirely ferruginous: head large and broad, with 2 small lateral eyes, and 3 simple ones forming a triangle on the crown; mouth with an upper and under lip, the latter with two 4-jointed hairy feelers; there is also a pair of tridentate spreading jaws, and 2 hairy lobed maxillæ, furnished with very long slender 6-jointed and hairy feelers: the trunk is elongated and oval: the body is broader, oval, pitchy, 7 or 8-jointed, and rough at the base, where it is very much narrowed, the 2nd segment is sometimes rusty at the base; it is depressed in the males, but slightly compressed in the females, with a short, scarcely visible ovipositor: 4 wings very iridescent and pubescent; superior very ample, with 1 large marginal, 3 submarginal, and 2 small discoidal cells; stigma very long and slender, smoky as well as the nervures; under wings very much smaller: 6 legs ochreous, hinder the longest; feet 5-jointed, tips smoky, and terminated by minute claws.

These little Ichneumon-flies were bred in June from the pupæ (figs. 26 and 27), and were abundant about twenty years since, but I never meet with them now.

The other parasite is included in the FAMILY CHALCIDIDÆ and the GENUS PACHYLARTHRUS: it is named by Mr. Haliday, from its brilliant emerald colour,

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* *Vide* Curtis's 'Brit. Ent,' fol. and pl. 141.

14. P. Smaragdinus.* It is only $1\frac{1}{4}$ line long, and scarcely expands 3 lines: it is of a charming green colour, thickly punctured: the *Male* has bright ochreous horns, composed of 13 joints, the basal one very long, the 3rd and 4th exceedingly minute; the maxillary feelers are terminated by a large oval orange joint:† the head is broad, the compound eyes are black, with 3 little simple eyes in triangle on the crown: the trunk is obovate and not so broad: the body is still narrower, small, oval, and of a metallic lustre; the base is contracted, and at the extremity is a curved horny sexual organ; the 4 wings are transparent; superior ample, nerveless, excepting a costal nervure, which forms a short capitate branch beyond the middle: 6 legs clear-ochreous, coxæ green; feet 5-jointed, tipped with brown. *Female* larger, blue-green; horns black; feelers not incrassated: abdomen larger, with an oviduct concealed beneath: legs ochreous white; thighs green, excepting their tips; middle of shanks brown; tips of feet black.

I have frequently bred these splendid little flies the end of April, in May, and October, from the pupæ of the *Tephritis Onopordinis,* but whether the *Pachylarthrus* is a direct parasite, and punctures the larva of the *Tephritis,* or lays its eggs in the pupæ already occupied by the *Alysia,* which in all probability is the case, has not been ascertained.

The *Alysia* is undoubtedly a natural check, which is provided to arrest the excessive multiplication of the celery and parsnip-flies; and the *Pachylarthrus* may be the agent to regulate the multiplication of the *Alysia,* in order that the *Tephritis* may not be exterminated. It is not, however, difficult to free a crop from the maggots, and although they have not been detected in affecting the parsnips materially, they have entirely destroyed the most promising crops of celery, and there is one, if not more wild plants in whose leaves the eggs are also deposited, for I have bred the flies from blisters in the foliage of an umbellate species called "Alexanders," the *Smyrnium Olusatrum.*

A top-dressing of gas-lime, soot, wood-ashes, or lime, when the blisters are discovered, might be useful in destroying the maggots as they fall from the leaves to bury themselves, so that the pupæ would not hatch; or, if given immediately on the appearance of the first blisters, in all probability it would deter the flies from laying their eggs, and thus the evil might be evaded: but the most simple and certain remedy is the operation of pinching the blisters, which must destroy the maggots at once, and this could

* Curtis's 'Guide,' Genus 631, No. 1. Phagonia smaragdina: 'Brit. Ent.,' fol. and pl. 427.

† Ibid. fig. iv. and other dissections.

easily be accomplished by children with a woman to see they did their work well. In any small plot or garden, an evening or two after work would be sufficient to ensure their destruction.

When the parsnips are left for seed, the yield is often terribly injured and diminished by the larvæ of the little moths which infest the carrots, as we have already stated.*

There is also a species which, from its name, seems to be especially attached to the parsnip, yet I am not sure it may not be identical with *Depressaria Daucella.*† It has been, however, described by Zeller and figured by Duponchel ‡ as *D. Pastinacella,* and M. Zeller has reared many hundreds of the caterpillars, which live in July upon the flowers and young seeds of the parsnip. They are greyish-blue, with the head, thorax, and pectoral feet black: upon each of the segments are 6 distinct little black dots, producing single minute hairs; the sides and the belly are yellow, and the abdominal feet are dotted with black. They sometimes eat into the stems of other plants and there change to pupæ: they have been thus observed in the stalks of the common cow-parsnip, *Heracleum Sphondylium.*§

15. D. Pastinacella has the head, palpi, horns, thorax, and the upper wings grey, more or less mingled with red, having broken longitudinal black lines corresponding with the nervures, and terminating at the extremity of the wing in little black dots or short lines: on the disc is a minute white dot elongated in the direction of the nervure and circled with black; cilia reddish; inferior wings ashy-grey, very shining: the abdomen and legs of a similar tint: the wings expand about 11 lines.

It is an inhabitant of Bohemia and Austria, as well as of France. There seem to be no better modes of ridding parsnip crops of these caterpillar pests than hand-picking, and shaking the umbels over a gauze net, for the larvæ to fall into.

The last enemy of the parsnip to be noticed is the *Aphis Pastinacæ,* which is so similar to the turnip-leaf plant-louse,‖ that I doubt if they be not the same.

16. A. Pastinacæ is yellow or green: the head, disc of thorax, and back of abdomen are black, as well as the horns, which are 7-jointed, but not long: the abdominal tubes are long and tapering: the wings are transparent, the nervures pale-brown; the

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* *Vide* p. 182.

† *Vide* p. 184.

‡ Godart, 'Lep. de France,' vol. xi. p. 153, pl. 291, fig. 4, 5, Hæmilis Pastinacella.

§ 'Annales de la Soc. Ent. de Paris for 1844,' pl. 6, b.

‖ 'Journal of Roy. Agr. Soc.,' vol. iii. p. 53, pl. C, f. 1 and 2, Aphis Rapæ.

stigma is smoky-green: the legs are ochreous, sometimes tinged with green; the hinder thighs are reddish-brown at their extremities; all the shanks are black at their tips, and the feet are of the same colour: length ⅘ line; expanse 3 lines.

This *Aphis* resorts to the parsnips the beginning of June, but I have never known any fatal effects from its inroads, as amongst the carrot crops. The *Aphides,* however, which last summer smothered such a great variety of fruit-trees, shrubs, vegetables, and flowers, were congregated in countless myriads on the underside of the parsnip leaves, and there they died packed close together with their heads down and their wings a little elevated over their backs.

### *A Summary of the present Essay.*

*Parsnips* perhaps the best *substitute* for the *potato.*

*Carrots* subject to the *attacks of* a variety of *insects.*

The *carrot-leaf plant-louse killing* one-tenth of the *crops* about Midsummer.

*Powdered tobacco* dusted over the carrots, or watering them with a *decoction of tobacco,* will *kill* the *aphides.*

Another species of *aphis* infests the *roots* in the autumn.

The *Rust* is occasioned by the *maggots of* a fly called *Psila rosæ.*

These *maggots* infest the *carrots* in summer and winter, boring *labyrinths* round and through the *tap-root.*

They change to *pupæ* in the *earth,* and the flies are hatched in the spring.

*Slugs* and *Poduræ* also inhabit the unsound *roots.*

The *maggots of Psila nigricornis* are, probably, equally injurious.

Sometimes they attack the *carrots* when very *young.*

*Remove* the *infested roots* as soon as the leaves turn yellow, and *burn them.*

*Trenching* the ground in the autumn, one of the *best securities against* most *insects.*

A dressing of *spirits of tar and sand before sowing* has been successfully tried.

*Pigeons'* and *cow-dung* pointed-in at the time of sowing, will *secure the crop.*

*Quick-lime* sowed and ploughed-in will *free the soil from maggots.*

*Millipedes* and *centipedes* also infest the injured *carrots.*

The *Otter caterpillar* of the ghost-moth will *devour carrots* as well as hop-roots.

*Draining* is *circumscribing* the localities of many *insects.*

The *swallow-tail butterfly* lays its eggs on the *carrot.*

The *caterpillar* feeds upon the *leaves,* also on the *rue, fennel,* and *marsh milk-parsley.*

The *common flat-body moth* lays its eggs on the *carrot flowers,* or in the axils of the leaves.

The *caterpillar* forms little cylinders of the *leaves,* which it also *eats.*

*Solitary-wasps* collect these *caterpillars* to feed their young.

The *caterpillars* change to *pupæ* in the *earth* or in the *rolled leaf.*

There is a *summer* and an *autumn brood.*

The *purple carrot and parsnip-seed* flat-body *moth* is generated on the *wild parsnip.*

The *caterpillars* feed on the *flowers and fruit* in July and August, living in society.

They become *pupæ in the web* in *summer,* but in the *autumn* they are *transformed* in the *stalks.*

The *moths hybernate*, sheltering in thatch, outhouses, under loose bark, in chinks, under stones, &c.

If a few *parsnips* be planted amongst the carrots, the *caterpillars will resort to* the former and leave the latter untouched.

The *grey carrot-blossom flat-body moth* is *not abundant* in *England.*

The *caterpillars destroy* entire crops of *carrot and parsnip-seeds* on the Continent.

They *live* in a *web* formed in the *umbels* which they devour.

Some change to *chrysalides there,* whilst others *bore into* the *stems.*

By *shaking* the *flower and seed heads* over a sieve the *caterpillars* may be *collected* and destroyed.

*Hellebore-powder,* and perhaps *lime* and *soot,* dusted over the umbels, *would drive them away.*

They so greatly *prefer* the *parsnip* to the *carrot,* that the seed of these may be *preserved* by *planting some* of those *amongst them.*

The *parsnip-heads* must then be *cut off* over a sieve and *burnt.*

*Two Ichneumons* lay their eggs in these caterpillars, and their maggots *destroy them.*

The *carrot gall-fly* is bred from galls in the umbels of flowers.

The *galls* are probably the work of some *Cynips* or *Cecidomyia,* and the *Callimome Dauci* is most likely a *parasite.*

The *galls contain* little *orange maggots* in the autumn.

A fly (*Tephritis solstitialis*) is supposed to be attached to the *carrot.*

*Parsnips get "rusty"* in the spring, but do not suffer like carrots from this malady.

T

The *maggots* of *Psila rosæ,* and probably *P. nigricornis,* infest them.

The *parsnip* and *celery miner* is a *maggot* living in *blisters* on the *leaves* in the summer and autumn, and has destroyed entire crops of the latter.

They change to *pupæ* either in the *blisters* or in the *earth.*

The beautiful *flies* are *hatched* in the *spring and summer.*

*Alysia Apii*, a *parasite,* lays its eggs in the mining maggots, and are found in June.

*Pachylarthrus Smaragdinus* probably *destroys* the direct *parasite* by laying its eggs in the pupæ of the *Alysia.*

The *mining maggots* may be effectually overcome merely by *pinching* the *blistered leaves.*

A *top-dressing* of *gas-lime*, *soot*, *wood-ashes,* or *lime* might kill the maggots when they bury themselves.

A little flat-body moth called *Depressaria Pastinacella,* is bred upon the *parsnips.*

The *caterpillars* are very destructive to the *flowers and seeds.*

*Hand-picking* and *shaking* the infested *umbels* over a sieve to collect the *caterpillars*, are the best *remedies.*

The *parsnip-plant-louse* is found upon the *leaves and flower-heads,* and it is closely *allied* to the *turnip-leaf aphis,* if not identical.

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EXPLANATION OF PLATE T.

Fig. 1. A carrot-root affected by "rust," and showing the mining of the maggots.
Fig. 2. The tails of the maggots sticking out, the heads being buried in the root.
Fig. 3. The root divided to show the depth of the injury.
Fig. 4. The larva of its natural size.
Fig. 5.* The tail showing the two black spiracles.
Fig. 6.* The larva or maggot magnified.
Fig. 7. The pupa of the natural size.
Fig. 8.* The same magnified.
Fig. 9. The fly named *Psila Rosæ*, walking.
Fig. 10.* The head in profile, showing the eyes, mouth, &c.
*a.** The two drooping horns.
Fig. 11.* *Psila Rosæ*, female, magnified.
Fig. 12. A young carrot-root injured by the maggots.
Fig. 13. The moth, *Depressaria Cicutella*, at rest.
Fig. 14.* The same flying, but magnified.
Fig. 15. The male of *Depressaria depressella*, the purple carrot and parsnip-seed moth at rest.
Fig. 16.* The female flying and magnified.
Fig. 17. An umbel of the flowers spun together by the larva.

Fig. 18. The caterpillar which spins the web.
Fig. 19. The chrysalis or pupa.
Fig. 20. *Callimome Dauci*, male.
Fig. 21.* The female magnified.
Fig. 22. A leaf blistered by *Tephritis Onopordinis.*
Fig. 23. The mining maggot under the skin.
Fig. 24. The maggot taken out.
Fig. 25.* The same magnified.
Fig. 26. The pupa.
Fig. 27.* The same magnified.
Fig. 28. The female fly *Tephritis Onopordinis* walking.
Fig. 29.* The male flying and magnified.

*Obs.*—Those numbers with a * attached refer to the objects which are represented larger than life, and all the figures are drawn from nature.



*Hayes, near Uxbridge, May,* 1848.

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## VIII.—*On Temporary Tile-Kilns.* By Th. Law Hodges, M.P.

*To Mr. Pusey.*

My dear Sir,—The experience of four years, that have elapsed since the date of my letter to the late Earl Spencer, published in the fifth volume of the 'Proceedings of the Royal Agricultural Society,' p. 551, has thoroughly tested the merits of the temporary clay-kiln for the burning of draining-pipes described in that letter.

I am well aware that there were persons, even among those who came to see it, who pronounced at once upon the construction and duration of the kiln as unworthy of attention. How far their expectations have been realised, and what value belongs to their judgment, the following short statement will exhibit:—

The kiln in question was constructed in June, 1844, at a cost under 5*l.*

It was used four times in that year, burning each time between 18,000 and 19,000 draining pipes of $1\frac{3}{4}$-inch diameter.

In 1845 it was used nine times, or about once a fortnight, burning each time the same quantity of nearly 19,000 pipes.

In 1846, the same results.

In 1847 it was used twelve times, always burning the same quantity. In the course of last year a trifling repair in the bottom of the kiln, costing rather less than 10*s.*, was necessary, and this is the only cost for repair since its erection. It is now as good as ever, and will be worked at least once a fortnight through the ensuing season.

The result of this experience of four years shows not only the practical value of this cheap kiln, but Mr. Hatcher, who superintends the brick and tile-yard at Benenden, where this kiln stands, expresses himself strongly in favour of this kiln, as always producing better and more evenly burnt pipes than either of his large and regularly built brick-kilns can do.

It will also be a satisfaction to those interested in the progress of agricultural draining, to know that draining-pipes, of the various dimensions mentioned in my letter to Earl Spencer, continue to be made and sold by Mr. Hatcher on his own account, at the same prices therein stated, except that in future he must charge, for $2\frac{3}{4}$-inch pipes, at the rate of 28*s.* per 1000. This necessity arises from their large size and weight requiring them to be placed on their ends for drying, instead of being hacked horizontally as other and smaller pipes; there is also greater difficulty in setting them in the kiln for burning. He makes now 3-inch pipes at 40*s.* per 1000, which are not mentioned in that letter. The reason for an increased price is obvious, as these pipes take double the quantity of clay required to make a $2\frac{1}{4}$-inch pipe, which he sells at 20*s.* per 1000. The cylinder of the machine requiring to be twice filled to the other's once—causing thereby double labour in their making, as well as in the previous process of digging and preparing the clay. With this trifling exception, the whole of the process of tile-making by Hatcher's machine, and the prices of each sort of pipe, continue the same as described in that letter.

I am, &c.

THO. LAW HODGES.

*London, April* 19, 1848.

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This temporary tile-kiln has always appeared to me a very valuable invention for those landowners who have drainage to execute on a small scale at a distance from a cheap tile-burner, or in the neighbourhood of a dear one, whom the mere preparation for raising a temporary kiln may induce to lower his prices. Such at least has been the result of my own experience, as without Mr. Hodges' paper on Temporary Kilns I should not have been able to buy inch pipes at 10*s.* per 1000; others, therefore, I should hope may find the power of burning their own tiles a defence against exorbitant charges. PH. PUSEY.

## IX.—*The Present State of Agriculture in its Relations to Chemistry and Geology.* A Lecture delivered before the Society at the Meeting in York, by Professor JOHNSTON.

MY LORD YARBOROUGH AND GENTLEMEN,—It is a striking circumstance, in connexion with vegetable growth, that some plants are seen to thrive on one kind of soil, or on one geological formation only. You meet with them in abundance in one country or district of Europe—where chalks, or marls, or limestones, or similar sandy or salt-bearing soils occur—while in the rest of Europe you seek for them in vain. But the grasses on which herbivorous quadrupeds thrive, are seen on soils of almost every kind, if the climate favour them; and the corn-bearing plants on which man lives find their support on every geological formation.

Is it illogical to perceive in this striking fact an evidence of design?—to infer from it that the Deity wills that man and his domesticated races should subdue and people the whole earth?

But on inquiring into this fact more nearly, we make two further observations: first, that the corn and herbage do not grow with equal luxuriance on all soils, or give an equal return; and second, that on the same soils on which, when left to themselves, they grow in an unhealthy manner, they prosper greatly when tended and cared for by human skill.

Is it illogical, again, from these facts, to conclude that the Deity intends the soil to be tilled, not only with the sweat of the brow, but by the efforts of the intellect of man? If it yield most abundantly to the thoughtful and instructed cultivator, is not the purpose of the Deity manifest—that mental should combine with bodily industry in making the most of the universal proneness of the earth, everywhere, to produce the means of sustaining human life?

Now we cannot walk through our rural districts and look at the young corn in spring without being struck with the varying verdure as we proceed from enclosure to enclosure, or from farm to farm. The sickly yellow and the smiling green each silently but distinctly expresses the natural deficiencies of the soil, or the careful attention of the husbandman. Among the large assembly I now address, I will venture to say that there is not a single practical man to whom such appearances are not familiar, and who, during the past unusual month of May, has not often said to himself, "If this or that field were mine, the corn should soon put on a livelier hue—the crops which that farm promises would neither satisfy myself, nor satisfactorily pay my rent." In other words, there is a large breadth both of our arable and our

pasture land which could easily be made, and by known means, to yield a greatly increased return.

How comes this state of things to exist? Some of you may answer, because obstacles everywhere stand in the way of agricultural improvement, which obstacles ought to be removed. The leasehold tenure of land in many parts of England, you may say, and the law of entail in Scotland, restrain the zeal or tie up the hands of the landlord; or the relations between landlord and tenant are too undefined and uncertain to justify the latter in putting forth all the energies of his mind and purse in improving the land he holds. To such answers as these I attach much weight, and they refer to a kind or class of obstacles which I believe does really stand in the way of the broad and general advancement of the agricultural productiveness of the country; but they do not meet the reflection with which I commenced, nor the peculiar train of thought to which I wish at present to confine your attention.

The walk I suppose you to have taken in the early spring is over a limited district, in which the law is the same to every landlord, and the customary tenure alike to every tenant. Yet, even here, the deep green of one field contrasts with the pale yellow of another, and while the promise of return in autumn may on one farm be little more than five, on another it may be fifteen fold. The green field and the yellow are under the same circumstances of law and tenure. How come they then to yield, the one forty bushels cheerfully and almost joyfully, the other a bare twenty bushels, and not without a grudge?

In replying to this question we cannot help fixing our attention especially on the influence and power of knowledge. The green field is the most skilfully laboured; the more productive farm is under the direction of a higher knowledge.

Some of you may indeed say, and not without justice, that of your own two neighbours whose farms thus differ, the one has more natural energy than the other, and to this difference you may be inclined to trace the relative degrees of prosperity of themselves and of their farms. But energy in a moral sense, if not the child, is in reality among the nearest of kin to sound knowledge. How many men, rich in physical energy, stand with folded and idle hands because they are poor in knowledge! Tell such a man what he should do and he is ready and willing to act. He stands still because he cannot see his way. He is uncertain because he cannot make out which of two plans he should choose. He is negligent, only because he is ignorant of what he ought to do, or of how it may best be done. Or if, in his physical impatience, such a man rushes forward, he fails to reach his aim because he is deficient in the materials for successful action.

How often do we see the energy of one man ill or wrongly directed because he knows too little of what he engages in, while, under the guidance of knowledge, every step, impelled by the energy of another, is observed to be a sure stride in advance!

Conceding, therefore, that there are many minor obstacles with which practical agriculture has to contend, and which its friends will labour assiduously to remove, I look upon defective knowledge, on the part of us all, as the first and most serious obstacle, and the one which we ought to work the hardest to take out of the way. But this defective knowledge may be regarded in two aspects. We are ignorant as individuals, in comparison with what other men know; or the whole sum of existing knowledge is defective, compared with what yet remains to be discovered.

In our standard books, and in the heads of the smaller number of our scientific and practical men, there exists a large amount of valuable information which is more or less completely unknown to the mass of our actual farmers. This head knowledge guides the hands of the skilful, tempers their energy, and by what we might almost call a mysterious sympathy, persuades the willing soil to yield increased returns. Such knowledge as this may become the property of all, and should be made readily accessible to all. The common good of the landlord and the tenant—of the manufacturing and the agricultural interests—is involved in its general diffusion among all classes of the agricultural community. The college and the school, the professor and the schoolmaster, are tools which here, in England, have scarcely as yet been employed for this purpose. It is true that meetings like the present, which are more or less frequent in our several counties, are a kind of large Lancastrian schools, where every man is monitor to his neighbour. Some of the grown scholars read and commit their yearly lessons well, and think over and digest them from month to month; while upon the mass—unapt to learn, and untrained to think—they produce but a faint and fading impression.

Of late years also a lesson in science has been conjoined at these meetings with the previous practical teaching on the construction and use of implements, and the qualities and rearing of stock. From this well-considered arrangement good results cannot fail to flow. Among the thousands who come here together, there are many whose minds are more inclined to the intellectual than to the purely practical, and who are interested as much by an exposition of the reasons of things as by the sensible study of the things themselves. To such minds your discourses on science supply appropriate food, and you enlist them almost unconsciously as propagators of that higher knowledge you desire to spread.

But this sipping of the waters is not enough for any: their sweetness may linger for a time on the palate, but, if long untasted, is apt to be forgotten. The rising agriculturists of a higher grade must be induced to repair to the very wells of knowledge, and to linger around the clear fountains till their thirst is not only awakened but fully slaked. For the less able portion of the rural community, instead of providing the rare and learned teacher on great occasions to give a single lesson, we must plant more frequent teachers in humbler dress to give instruction to the growing youth around their daily doors. By these, among other methods, the diffusion of existing knowledge will be hastened, equality in agricultural skill promoted, and with it that more uniform culture and productiveness which experience shows to be possible, and which it is so much the interest of the nation to bring about.

There are tracts of country on the surface of the earth, where drought and constant barrenness prevail, while in others too frequent rains impede the labours of the husbandman, and mar his hopes of profit. Were the rains that fall made equal everywhere, or adjusted to the prevailing warmth, philosophers say that arid deserts would disappear and universal verdure overspread the sandiest plains. It is so also with the waters of knowledge. Spread them uniformly and there is enough to enlighten the mind of every living man. Make them come down, not as the thunder-storm, deluging a limited spot, but as the nightly dew softly dropping its cool freshness on the parched leaf, and there is enough to spread the fertility of Norfolk over the starved fields of Durham, and to make the farmers of Cheshire become successful rivals to the proud hunters of Lincoln.

And in behalf of the waters of knowledge these two things are further to be said. There exist in nature purely physical obstacles to the uniform fall of natural rain, which it has pleased the Deity to establish, and over which man has no control; but to the equalization of knowledge there exist only moral and institutional obstacles, which man has himself set up, or can himself remove. And whereas in equalizing the natural rain, that which is given to one part of the earth's surface must be taken from and lessen that which formerly fell upon another part, there is this peculiar virtue in the waters of knowledge, that, like the widow's cruse and the barrel of meal, you may take from them daily and they become no less. The rich in knowledge becomes no poorer by imparting to others even all he possesses; nay, he cannot impart it in thoughtful earnestness without, by the very act, increasing his own store of high and happy thoughts. I might, indeed, liken knowledge most truly to a spark of heavenly fire,

which grows and extends the more, the more it imparts to other matter of its own light and heat.

I look forward therefore with interest and hope to the various methods now contemplated, or already in actual operation, for the diffusion of existing agricultural knowledge. As we advance in this useful work, the patchy green and yellow which now chequers the surface will gradually disappear, and verdure of a more uniform tint will overspread the largest breadths where soil and circumstances favour all alike.

But I advance to the second aspect in which our defective knowledge may be viewed, and on which it is my purpose at present principally to dwell.

If we study the actual condition of scientific agriculture, in any one of its branches, with the view of thoroughly mastering it, we arrive sooner or later at depths beyond which no one has ever gone. In other words, our existing knowledge, though great, is everywhere limited and full of imperfections, and, though rapidly progressing, is still unable to explain many important appearances, or to give explicit and satisfactory instructions in regard to many important agricultural operations.

The increase or progress of this knowledge ought to be no less a care and concern, therefore, than its diffusion should be, to the friends of rural improvement. Especially it ought to be a matter of moment to a great Society like this, and an exact acquaintance with the state of that progress not uninteresting to the more intelligent and instructed of its members.

Instead, therefore, of addressing you in the present lecture upon the elementary scientific principles which bear upon some question of practice, or occupying your time by discussing the details of some more or less important branch of the rural art, I believe I shall consult more the importance and dignity of this national meeting by endeavouring to set before you a brief outline of the actual condition of scientific agriculture, and especially of the present state of rural economy in its relations to chemistry; and this I hope to do so plainly, that while it shall be generally interesting to such as take wider views, it will at the same time be as intelligible and instructive to all as a more elementary and common-place address would have been.

Now in regard to this subject there are three distinct questions which will naturally arise in your minds :—

*First.* What has been the progress, in amount and in kind, which scientific agriculture has made among ourselves during the last ten years?

*Second.* What is the actual condition of this advancing knowledge? And

*Third.* What should now be specially done to further or make easy its advance?

I. As to the first of these questions, were we to judge from the character of the agricultural literature of 1848 compared with that of 1838, we should conclude that a vast stride had been made. At the latter period the aid of science was all but scouted among the leaders of agricultural opinion in the different parts of England; and the strength of the agricultural periodicals, when they touched upon the subject at all, was for the most part expended in undervaluing the worth of natural science to the farmer, and in especially ridiculing the pretended value of chemistry. Now the weekly journal is considered badly conducted which in every number does not embody some scientific and especially some chemical information. Scarcely a provincial paper which boasts an agricultural corner but indulges freely in chemical nomenclature, as being now agreeable to the taste and within the easy comprehension of almost every farmer; while the bearings of geology and physiology on matters of rural industry are discussed by countless correspondents in the increasing though still too limited agricultural periodicals.

But though in a free country like ours the periodical press must follow the public lead, and may be regarded as a fair general index of the taste and tone of the public mind at any given period, yet the improved character of the agricultural journals marks rather the progress of the people than the progress of science—the diffusion of existing information rather than the actual advancement of science itself. I shall enter therefore a little more into detail.

When about eight years ago I began first to study with the view of writing upon this subject, my attention was especially arrested by three several circumstances:—

*First*, by the want of correctly-ascertained facts in experimental agriculture. The benefits of this or that mode of procedure, the effects of this or that substance upon the soil or the crop, I found described in books in a loose or general manner. From the earliest times experiments have been made in practical agriculture. We may almost say that the entire art, as practised in climates and upon soils such as ours by improving men, is one nearly unbroken series of trials; but precision in regard to weight and measure was scarcely ever attended to: a rough guess at the produce generally satisfied and probably served the purpose of the experimenter. The influence also of important varying circumstances upon the results of the trials was little attended to, or at least seldom thought worthy of an accurate and permanent record.

In truth, agriculture has scarcely been regarded by its followers as a branch of book-learning at all. The knowledge of it was generally transmitted directly from mouth to mouth; and as

it was rarely sought from books by those who practised it, so those who wrote rarely committed to paper the details of what they had observed, or made their trials with the view to after-publication.

And yet I need not explain to you how necessary, in all the sciences of observation, is a precise attention to facts, and a careful record of them. Facts so ascertained and recorded are the very stepping-stones by which any sure advance can be made. Without them no safe opinions can be formed by ourselves, nor can the opinions of others be satisfactorily tested or fairly criticised.

*Secondly.* In the second place I was struck by the currency, in theoretical writings, of a crowd of hasty hypotheses, some of them scarcely deserving the name of guesses at truth—propounded often with confidence, and received as ascertained principles, though there were no unexceptionable facts to support them, nor exact experimental data by which to test them.

It is one thing to write for distinction, and another for the illustration or advancement of the truth—one thing to propound ingenious and brilliant conjectures, and another to bridle in one's own hasty exuberance, and after cautious consideration only to bring our opinions before the public—as the wary farmer winnows well and cleans and hand-picks the corn he intends to offer in competition for a prize. The less cautious and profound have hitherto been the most numerous among the writers upon agricultural theory; but it was the same with the other sciences of observation until a very recent period. Speculations and fanciful theories—beautiful, highly poetical often, and indicative of high talent—formed, less than a century ago, the staple philosophy of the chemical and geological sciences. Number came, however, and weight and measure, and the use of exact instruments, to be applied to these branches of knowledge; and before them the brilliant imaginings of the early writers have sunk into forgetfulness. And so it will be in agriculture. The well-weighed and thoroughly-tested notions—deductions I ought rather to call them—of our agricultural writers will alone retain their place in the rural creed of the coming generation.

You will, I am sure, excuse me if I venture to add, from my own experience, that the constant demand for excitement and novelty which widely prevails among the agricultural body, exercises upon those scientific men who are engaged in your behalf an amount of pressure from without which is unfavourable, in a high degree, to that calm deliberation and well-digested maturity of views so necessary to sure progress in science. Be cautious whom you trust or select for employment in your service; but, having exercised this caution and wise discretion, wait patiently for those results which are sure to follow more or less immedi-

ately from well-directed labour—and, if not yourselves, to repay your sons at least for the outlay of money you may have incurred.

*Thirdly.* I was struck, in the third place, with the wide gaps and deficiencies which everywhere presented themselves in our analytical knowledge of matters connected with rural economy. Of the soil, the plant, and the animal—their chemical nature, their composition, their food—analysis, though long employed upon them in a desultory manner, had left much untouched which the farmer asks to know. The same was true of the chemical history of animal and especially of vegetable life—a knowledge of which appears every day more necessary to a secure practical progress.

Besides these three main observations, I met also with numerous acknowledged facts in practical agriculture for which no explanation, in accordance with existing knowledge, had been, and as it appeared to me, could yet be given; and it also occurred to me as somewhat remarkable, that, with the exception of botany, the other rapidly-progressing sciences of observation had been made use of in so small a degree to throw light upon the unintelligible and obscure in this most important of all the arts of life.

Such were the points which especially presented themselves in a review of the state of our knowledge on this subject eight years ago. It was natural therefore to suggest to the friends of agricultural progress the adoption of means by which the deficiencies in regard to facts might be gradually supplied, the theoretical redundancies lopped off, and the gaps in our knowledge of principles in some measure filled up.

It was first suggested therefore that accurate experiments in the field should be forthwith undertaken—made by weight and measure, and under varied circumstances; and instructions were published explaining the kind of experiments it was desirable to perform, how they should be set about, and the immediate ends they might severally be expected to serve.

It will at once occur to you, gentlemen, that the advantages likely to result from such precise experiments are by no means limited to the purposes for which they are immediately intended. They may or may not throw light on the points they were expected to clear up; but in either case they will suggest further experiments, and these again others, leading us on by a gradual progression to more extended acquisitions of knowledge.

Besides, though the first, and to science perhaps the most important, purpose of experimental research is to obtain facts which shall elucidate with certainty the causes of things, yet the prosecution of it, in connexion with rural economy, is fitted also to give a new interest to farming—to introduce more careful habits of observing and recording—to awaken much new thought, and

thus gradually to impart a higher tone to the minds of the rural population,—and to convert agriculture from an empirical art into an occupation suited to intellectual men.

To the less purely scientific these latter ends may appear not less important or worthy to be aimed at than those for which experiments are in the first instance recommended. It is certain, indeed, and is worthy of general and serious consideration, that the prosecution of all the arts of life, as masters or leaders, will ultimately be wrested from the hands of the unintellectual, who must become the Gibeonites of their class. The progress of such changes in society, if measured by the length of a single life, may appear to be slow, but it is a sure progress. The sons of some whom I now address may live to hew wood and draw water for the sons of others who now move in the same sphere, and occupy a similar position with themselves; and these sons of yours, looking back with regret to their neglected youth, may forget to load your memory with natural blessings—when they feel how much the wiser affection of other parents has raised their children above the less-instructed companions of their youth.

The second point urged upon the agricultural public was the rejection from among received views of every opinion, by whomsoever propounded or propagated, in support of which there were no un-mistakeable facts, or in favour of which the balance of known observations did not appear distinctly to incline. Erroneous opinions are the rubbish which encumbers and conceals the foundations of truth. To clear away this rubbish is to make our work of discovery more easy. To remove from our books a wrong opinion, which had obtained a prominent and settled place in them, or which has been introduced on the authority of a great name, is as useful to the progress of science as the establishment —is in fact often half way, if I may so speak, to the establishment—of an important truth. The inculcation of this cautious spirit has, I believe, been attended by the best effects; and the heads of the rural community are less likely now to be turned by the mere beauty of poetical theories than they were a few years ago.

It was suggested, in the third place, that analytical researches of various kinds should be undertaken in the laboratory, at the cost, under the direction, and for the immediate benefit of the practical agriculturist, and for the direct advancement of his art. This suggestion led to the establishment of agricultural chemistry associations in Scotland, Ireland, and England, in the order in which I have named these countries,—to the formation of similar institutions in the United States of America, and in various countries of Europe,—and to the numerous researches which private individuals have made in aid of this department of agricultural science.

In addition to the objects thus suggested, and more or less strongly recommended, scientific men have applied themselves, by personal observations on the farm, to the study of hitherto unintelligible or unexplained facts—in the belief that a knowledge of the conditions or circumstances under which they present themselves is the surest preparation for a satisfactory discussion of their causes. Other branches of science, also, have been applied to the art of culture; and by the aid of geology, entomology, physiology—animal and vegetable—and of various branches of physics, attempts have been made to throw light upon points hitherto less clearly understood.

II. And what, you will ask, has followed from these suggestions? What actual advancement has been made in consequence of them? On what higher vantage ground does scientific agriculture now stand?

Were I to answer this question in detail—to enter, as some few of you might wish, into a statement of the numerous ways in which practical agriculture has, during these ten years, been helped forward—I should detain you far longer, upon this point alone, than the most zealous of you could lend me a willing or patient attention. Indeed one of the greatest points we have gained, perhaps, is this, that the value of science—of chemical science especially—to practical agriculture, is no longer a matter of dispute. Its importance is now everywhere, and in every civilized country, readily conceded; and large bodies of men, who five years ago either openly opposed or lukewarmly supported its application to rural affairs, are now most forward to obtain a share in the honours of its advance, and to be identified with the benefits it is likely to confer upon practical agriculture.*

But though time does not permit me to answer in detail this question, in regard to our actual progress, yet there are a few important points to which it is needful that I should refer.

*First.* As to experiments in the field, I need hardly tell you that much has been done. Numerous trials, especially with different manuring substances, have been made,—by some from their own wish to aid in the advancement of knowledge, or with a view to their own profit, and by others through the encouragement chiefly of the Highland and Agricultural Society of Scotland. In the Transactions of that Society are recorded by far the most numerous and apparently accurate and carefully conducted

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* Such as wish to study this matter in detail may consult with advantage the speeches of Mr. Huxtable at Drayton Manor, and at the late meeting of the English Agricultural Chemistry Association, the papers of Mr. Way and Mr. Lawes in this Journal, and the published Proceedings of the Agricultural Chemistry Association of Scotland.

body of agricultural experiments which have hitherto been collected together. From these experiments, and from others made in England and Germany, certain important deductions may be safely drawn—such as,—

*a.* That substances rich in nitrogen increase the verdure, lengthen the straw, and generally promote and prolong the growth of plants.

*b.* That lime, in its more common forms, generally shortens the period of growth, strengthens the stem, and hastens the time of ripening, both of corn and root crops.

*c.* That certain saline substances, applied alone, and even in comparatively minute quantity, produce a remarkable—what may almost be called a marvellous effect—upon certain crops on certain soils.

*d.* But change the crop, or the soil, or the season, or apply them in the same circumstances a second or a third time, and frequently no sensible effect will follow.

*e.* That where one substance applied alone refuses to produce a visible effect, a mixture of two or more may give rise to striking differences.

*f.* That phosphoric acid, lime, and certain forms of organic matter are essential constituents of such a mixture as shall everywhere, and in all circumstances, produce a marked and beneficial effect on old cultivated land, to which no other manure is applied.

Such general deductions as these are important bases for future practical researches, and perhaps to have attained a degree of certainty in regard to them alone is worth all the expenditure the experiments have cost. We have, indeed, other more special conclusions which may be regarded as *probable;* for instance—

*a.* That the so-called soluble saline substances—the salts of potash, soda, magnesia, &c.—are grateful to our root crops, in which they largely exist.

*b.* That those which contain sulphuric acid have a specially beneficial action upon leguminous plants.

*c.* That the use of common salt adds weight to the grain.

*d.* That on mossy land the use of bones tends to fill the ear.

*e.* That lime and salt are better than lime alone on some soils, in giving strength to the straw.

*f.* That mineral manures, applied alone, act like lime, in shortening the period of growth.

Such *probable* deductions are not without an actual money value as guides to the practical man; but they are almost beyond price to an advancing science, as they point the way to new experimental researches, by which the domain of ascertained truth will be enlarged.

And yet from the mass of published experiments, and from the opinions—often hasty and badly founded, sometimes extravagant, and almost always far too general—which have been based upon them, there is much chaff to be winnowed, and many hurtful seeds to be sifted out. And that it should be so is not surprising, when you consider the numerous difficulties that lie in the way of the practical farmer in attempting to make experiments with scientific accuracy. He is supplied, perhaps, with impure materials, which he cannot himself examine, and for admixtures or adulterations in which, he can consequently make no allowance in judging of his results. Again, the carelessness, the culpable and generally concealed neglect, and even, in some cases, the opposition and unwillingness of his servants, are difficulties which he can scarcely altogether overcome: and further, he is himself most likely inexperienced in accurate observation, and thus overlooks some necessary precaution in conducting his experiments, which renders their results less trustworthy.

It has too often happened, also, that experiments have been undertaken without a definite purpose. The trials have been made without a clear knowledge of what was to be looked for, and points have thus been passed over which it was of importance to observe. The old alchymists, who made experiments upon every thing that came in their way, put materials of which they knew little into their retorts and crucibles, and heated them in their furnaces, on the chance of something curious or valuable turning up. The modern chemist, on the contrary, selects materials of known composition, mixes them in known proportions, heats them to a definite temperature, in a known way, and looks for a known or expected result. And so conducted, and carefully watched, must our future field-experiments be, if they are to advance or widen our real knowledge.

From the obstacles above noted have arisen, in many cases, the contradictory results we so frequently observe among our published experiments; and, generally, no means are afforded us for determining upon which of two or more discordant statements the greater reliance is to be placed. The soil, or the substance applied to it, has not been analysed—the history of the past treatment and present condition of the land is not given—the peculiarities of the weather, or of the local climate, are not noted—the physical geography of the neighbourhood is left out of view—the character, willing and attentive, or otherwise, of the workmen is not stated—or we know nothing of the general habits, skill, and education of the person who publishes and is responsible for the accuracy of the whole results.

Sometimes a previous acquaintance with the individual enables us beforehand to form a general opinion as to the degree of

credit to which his results will be entitled; and sometimes a mere perusal of the remarks he appends to them explains sufficiently the knowledge and mental tendencies of the experimenter, and the amount of attention which his trials deserve.

But without troubling you with any of the more refined modes of criticism, which when applied to a table of results often satisfy the reader that the whole must be unconditionally rejected, I will show you how the neglect of one or two very simple and intelligible precautions has rendered suspicious at least three-fourths of all the experiments hitherto published, and has necessarily excluded them from that body of satisfactory evidence on which safe opinions are to be based.

*First.* In nearly all cases of experiments with what have been called specific manures, the limits of natural differences in the crop on different parts of the same field have not been previously or simultaneously determined. One portion of the field has been left undressed, and the produce of that one part has been taken as the standard, with which the produce of the dressed or manured parts was to be compared. But how incomplete this method is, and how unlikely to lead to the truth, the following examples will show you:—

*a. As to Turnips.*—In 1843 Mr. Dockar, of Findon farm, Aberdeenshire, made experiments on turnips, which were afterwards published; and from two separate eighths of an acre of the same field, to which no manure had been added, he obtained

| | | |
|---|---|---|
| First portion . . | 8 tons | 11 cwt. |
| Second portion . . | 6 „ | 16 „ |
| Difference . . | 1 „ | 15 „ |

Or a difference of $1\frac{3}{4}$ ton upon a crop of 7 or 8 tons.

A similar result was obtained at Erskine, in Renfrewshire, where two portions of the same field yielded respectively

| | | |
|---|---|---|
| First portion . . | 12 tons | 17 cwt. |
| Second portion . . | 11 „ | 8 „ |
| Being a difference of . | 1 „ | 9 „ |

These two differences are equal to 25 and to $12\frac{1}{2}$ per cent. of the whole crops respectively.

*b.* So in the case of *natural hay.* Mr. Chalmers of Monkshill found two several unmanured eighths of an acre of an experimental field, to yield respectively at the rate of 385 and 281 stones of hay per acre, being a difference of 104 stones, or nearly two-fifths of the whole.

I do not quote more examples. These are enough, I think, to entitle us to ask of experimenters—Are such differences in the natural produce of different parts of the same field common, or

are they rare? Where are they likely to occur, and where not? Can we without actual trial say that any field will not exhibit them? How would your own fields behave in this respect?

If you will carefully examine the various tables of experimental results which have been published during the last three years, you will find that in very few cases only has an answer been sought for or given to this last question. The natural differences in the unmanured crops of corn, roots, and hay, on different parts of the experimental field, have rarely been investigated. And even where, as in some of the later series of experiments made at Barochan by Mr. Gardiner, two or more pieces of land were left undressed with a view to ascertain this point, the mean of the whole only is given, and the results of the manured portions compared with this mean. But it is the differences in the undressed portions themselves which it is desirable to know, as by them we are enabled to judge how far the applications we make to other portions of the same field have done good or harm.

Take, for example, Mr. Chalmers's meadow already mentioned; from one undressed portion of which he reaped 385 stones of hay and from the other only 281 stones per acre. The mean of these two is 333 stones. To one part of this field he applied 2 cwt. of gypsum per acre, and to another 4 bushels of bones dissolved in sulphuric acid, with the following results:—

| | | |
|---|---|---|
| 2 cwt. of gypsum gave . | 287 | stones per acre. |
| 4 bushels of bones dissolved | 268 | ,, |
| Mean of natural hay . . | 333 | ,, |

If we were to compare these results with the *mean* of the undressed portions (333 stones), we should conclude that these dressings had diminished the crop in the one case 46, and in the other 65 stones per acre. If we compare them with the maximum produce of the natural hay, the diminution appears still greater; but such a result is preposterous and contrary to experience, and therefore it is satisfactory to find, upon comparing them with the minimum produce of natural hay (281 stones), that the dressed parts gave sensibly the same weight of crop. We find reason to believe that they did no harm, and it is rendered probable that they acted beneficially as usual.

*Second.* But the same substance applied in the same quantity to different parts of the same field and crop produces differences of an equally marked character.

Thus Mr. Dockar of Findon, on the same field of turnips spoken of above, obtained from two portions, to each of which bones at the rate of 20 bushels an acre were applied, the following weights of bulbs per acre respectively:—

| | Tons. | Cwt. |
|---|---|---|
| 1st portion . . . | 11 | 9 |
| 2nd portion . . . | 8 | 14 |
| Difference . . | 2 | 15 |

—a difference of nearly 3 tons on a crop of from 9 to 12 tons. How much of this was owing to those natural differences in the soil which in unmanured portions gave rise to the difference in the crop of $1\frac{3}{4}$ ton per acre, which I have already quoted; and how much to some unexplained diversity in the action of the manure employed? Had anything in addition to the bones been applied to the first of these dressed portions, we should naturally have ascribed the increase of $2\frac{3}{4}$ tons to the special action of that substance. And yet how wrong would this have been, not only theoretically, but how much practical evil might it have caused! how much throwing away of money in the purchase of this substance by practical men in after years!

But I present you with a more striking illustration from experiments made in the island of Bute in 1847, and recently published. On the farm of Kerrytonlia, on a dry soil resting on the old red sandstone, three portions of the same field, manured alike with 24 carts of farm-yard dung and 16 bushels of bones, gave respectively $34\frac{3}{4}$, $32\frac{1}{4}$, and $27\frac{1}{4}$ tons of swedes. The differences were—

Between the 1st and 2nd portions, $2\frac{1}{2}$ tons.
Between the 2nd and 3rd portions, $7\frac{1}{4}$ tons.

On another farm, in the same island, that of South St. Colmac, the soil being a deep loam, three portions on the same field dressed with 5 cwt. of African guano each gave respectively of Dale's hybrid turnips (bulbs) per Scots acre—

| | Tons. | Cwt. |
|---|---|---|
| 1st portion . . . | 28 | 5 |
| 2nd portion . . . | 29 | 17 |
| 3rd portion . . . | 31 | 17 |
| Difference between 1st and 3rd | 3 | 12 |

What confidence can be placed, what numerical deductions can we venture to draw, from results differing so widely as these?

And then among experiments tabulated in a formidable manner, and with all the strength of numbers, we sometimes find it stated that less of a substance gave more, and that more of it gave a less produce. Thus on the field last quoted in Bute—

| | Tons. | Cwt. |
|---|---|---|
| 5 cwt. of guano in one experiment gave | 31 | 17 |
| 4 " " " | 32 | 0 |
| 6 " " " | 30 | 15 |

And on the field on the Kerrytonlia farm in Bute, on which the experiment already quoted was made,

| | Tons. | Cwt. |
|---|---|---|
| 24 carts of dung and 16 bush. of bones in one experiment gave | 27 | 7 |
| 24 „ 14 „ „ | 29 | 7 |
| Difference . . . . . . | 2 | 0 |

Again, on the same farm,

| | Tons. | Cwt. |
|---|---|---|
| 24 carts of dung and 3 cwt. African guano gave in one experiment . . . . . . . . | 25 | 4 |
| 24 carts of dung and 2½ cwt. guano . . . . | 28 | 7 |
| Difference . . . . . . | 3 | 3 |

Are these differences to be ascribed to the errors or carelessness of the experimenters or their servants? or do they signify that no exact numerical results are ever to be obtained from such experiments? It is unnecessary to discuss these questions in this place. It is enough for my present purpose to observe, that, inasmuch as the tables of results which we at present possess exhibit for the most part only one illustration of the effect of each substance or mixture employed, no strong reliance can be placed upon them as indications of what their mean or average effect would be upon the field as a whole, or upon its several parts taken singly.

I do not dwell on the very small portions of land on which some have made their experiments—on the form of these portions, as when one or two drills of a field are selected—on the want of attention to the previous chemical treatment, the historical husbandry followed upon it, and the chemical condition of the land at the time—for all of which, if we knew them, allowances ought to be made in the after criticism to which the results are subjected.

But the application of these and other tests has compelled me to the conclusion that a very small number indeed, out of the host of experiments made during the last five years, is really deserving of more than a general credit. They are to be trusted, as showing that this or that substance adds to the verdure, bulk, or weight of this or that crop in certain circumstances; but they are not to be depended upon as to how much these several substances do so either relatively or absolutely, or as to the degree by which their action is affected by this or that circumstance. In other words, the application of weight and measure in its strictest sense to this branch of applied science has yet to be made; and the field of precise agricultural experiment, instead of being pretty well colonized, as some think, may be said to lie still open and unoccupied before us.

But will not rough experiments, some may ask, answer most of the purposes for which field-trials are made? The same question is asked—the same thing, I may say, is believed—by some in regard to the chemical analysis of soils, manures and other matters connected with practical agriculture. With those who can ask such questions, it is out of place to reason. You must impart to them first something like your own amount of knowledge, or induce them to acquire it; and then they will, without reasoning, see things in your light.

Have our past experimental researches then as a whole done no good? I would say they have all done good. Examples of good, in the form both of certain and of probable deductions, I have already mentioned. But even where no such deductions at all can be drawn from them, or with any degree of certainty, the labour spent on none of them has in my opinion been thrown away. Is it nothing to have called forth so much new thought in the experimenter, in his assistants, and in the readers of his results?—to have imparted a definite form and meaning to the idea of scientific farming—to have given birth to new habits of observation and more precise modes of reasoning among so many of the agricultural class—to have led large numbers of men to possess themselves of books, and to read what otherwise would never have interested them—to have induced, as I believe they have directly or indirectly done, so many intelligent farmers to become members of a society whose formidable motto is 'Science with Practice,' and to take the lead, in their own districts, in the advancement of an art they were before unaware how materially they could assist in promoting?

I have spoken of these experiments in a purely scientific sense, as supplying contributions to our stock of reliable facts, worthy of a place in our books, and fit to form foundations for safe opinions, or to be employed in testing opinions already in vogue. In this sense they are defective: and yet, even with a view to this point, they are not without their use. They have taught us how to work more correctly, and have called out and trained up men who are capable of performing experiments in future years as they ought to be made. In commencing a new method of research in any department of knowledge, we must first learn how to proceed with accuracy before we can make any certain progress. And as this information can usually be obtained only by making actual trials, we must be content to fail many times while we are acquiring our experience. Lives may be well spent in this preliminary work, clearing the way for the rapid progress of our successors. How many long lives of ardent labour has general chemistry exacted from its cultivators in performing work now rejected and forgotten! The further we advance in every branch

of research, the more refined does it appear indispensable that our investigations should be, and the more practically and theoretically useful do such refinements evidently become.

To some the accuracy in field experiments of which I have spoken may seem to be only a speculative good; but to practical men it is in reality a matter of immediate money concern. The results of reported experiments guide you in your purchases of manuring substances, and have frequently, I have no doubt, led some of you to inconvenient loss.

*Second.* And this remark naturally leads me to advert to the manufacture of artificial manures as one of those circumstances which distinctly mark the kind of advancement which scientific agriculture has made amongst us of late years, and the position it now occupies.

The possibility of concentrating great fertilizing efficacy in a small weight or bulk has been satisfactorily demonstrated to every one by the remarkable effects of guano. In watching the progress of this branch of science, and marking the obstacles which have from time to time stood in its way, it has appeared to me as if the finger of Providence might, by serious men, be recognised in the introduction of this foreign substance. More corn was wanted to feed the growing people, and more manure to raise it. More portable and more manageable forms of manure also were desired, that it might be applied more frequently than hitherto, at times hitherto unusual, and in places hitherto not easily accessible. How many years of almost unavailing labour must teachers of science have spent before they could have satisfied the rural community, that large bulks of manure were, in many cases, unnecessary, and that the success of their crops might be trusted to the fertilizing action of any mixtures they might recommend! But guano came, and on the old principle that "seeing is believing," forced new ideas into the oldest heads, and a new belief into the minds of the least persuadable farmers. "I will try some myself next year" was the often unexpressed resolution of men convinced against their will, and the spirit of experimenting was widely awakened. Chemical analysis then took it up, explained the composition of guano, declared that it could be imitated at a reasonable rate, and published experimental recipes for compounding artificial mixtures to be tried against it. Immediately half-instructed men—supposing the practical conclusion already arrived at, which more cautious men were only beginning to seek for—hurried into what appeared to them a sure and easy way of making money. Artificial guanos and prepared manures qualified to do everything appeared in the market. The farmer, in many cases as credulous now as he was unbelieving before, bought them with

avidity, and that singularly ignorant transition state of things arose, by which the relation between the artificial manure manufacturer and the manure consumer in this country is at present characterised.

On the one hand we have a body of men, the practical farmers of England, among whom there is a greater number, I believe, of zealous, enlightened, and open-hearted improvers than in any other country. On the other, a crowd of persons, with that superficial amount of the necessary knowledge which in this country we call quackery, preparing manures for their use. We have numerous trials of their nostrums going on, numerous losses sustained by the farmer which we never hear of, and year by year the maker taking means to add a little to his own information, and if a failure in the demand admonish him, a little also to the real value of the article he manufactures.

Of course among the vast number who now follow this trade there are some who are more skilful and trustworthy—some I know to be highly honourable men—but this rarer few use harder words regarding their brethren in trade than I am willing to do. It is easy to foresee that this branch of business will by-and-by become one of the most important in the country, and will afford scope enough for many honest men to make an honourable livelihood. In the mean time having had occasion to analyse and to investigate the mode of manufacture of many of the artificial manures now on sale, I cannot refrain from publicly reprobating the unfair advantage so often taken of the inability of the English farmer to test before-hand the value of what, in his creditable efforts to improve, he feels himself almost compelled to purchase.

The sale of fraudulent manures—for ill-compounded manures, made up after defective recipes, are not mere adulterations—the sale of such manures not only causes loss in the first instance to the practical man, but it destroys his confidence in such preparations, retards the progress of the art, keeps down the yearly produce of the land, and seriously injures the honest and instructed manufacturer who deals fairly in what he makes.

And yet practical men are not themselves without blame in this matter: cheapness is by many farmers as much sought after as quality. The makers of manures have been obliged to consult this taste, and to the cheap, in many cases, to sacrifice the good nearly altogether. Some who, I know, are desirous of bringing into the market only what is deserving of confidence, and will bear a rigid examination, have thus written to me:—"We cannot afford to sell our pure manures at the price they will bring in the market. The competition of others prevents it. We are obliged, therefore, to reduce them by some cheap admixture;"

and that such is really the case you can easily satisfy yourselves by a very simple calculation.

Take the case of pure dissolved bones, or superphosphate of lime, as it is often called. Suppose this to be made in the cheapest way, by reducing three parts of bone-dust by means of one of strong sulphuric acid, and that the water added to dilute the acid in the first instance, is afterwards driven off by drying. This will be unadulterated dissolved bones; four tons of which will contain three of bones and one of acid. And what will be the lowest cost, taking the bones at 5*l*., and the acid (bought in large quantities) at 7*l*. a ton? 5*l*. 10*s*. a ton is the cost of the raw material, and if we add only 1*l*. for labour, the cost is 6*l*. 10*s*. a ton without any allowance for interest of capital, or for profit. Now, if you increase this sum by a fair profit, by charges for carriage, for commission allowed to agents—usually 1*l*. a ton, —for discount, waste, bags, &c., you will be able to judge whether those who profess to sell even this simple article of dissolved bones at 6*l*. or 7*l*. a ton, can really send you what either you unreasonably expect, or they untruthfully offer to you at so low a price. Such cheap articles are in reality diluted, with water left in them, with gypsum introduced to dry them up, or with some manufacturing refuse of uncertain composition. They are thus necessarily subjected to those variations in quality to which careless workmen everywhere give rise, and to which the refuse and other admixtures employed are themselves liable.*

One remedy and sure check for this state of things—which in a few years will no doubt come to a natural end—is to be found in the general diffusion among agricultural improvers of that limited amount of instruction which shall enable them to manufacture such mixtures for themselves. That this mode of meeting the difficulty is gradually making its way, I know from the numerous communications I receive regarding mixtures prepared and employed by practical farmers themselves; and that in this part of England the practice is on the increase, may be inferred from a statement lately published, that in the town of Spalding alone

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* This you will understand applies only to pure dissolved bones. The name of superphosphate of lime in the manure market is, unfortunately, given to preparations of very different kinds. Some make it by dissolving burned bones in acid, some common bone-dust, some Saldanha Bay guano, some the coprolites of the green-sand, and so on. This causes a diversity of composition in articles sold under the same name, which is injurious both to the consumer and to the maker. In the absence of other standards I would venture to suggest, that in every article sold under the name of superphosphate, the proportion of phosphate of lime (or of phosphoric acid) and of dry animal matter should be guaranteed by the seller. One means of comparison would thus be afforded to the buyer.

27,000 lbs. of sulphuric acid were sold last year for the purpose of dissolving bones.

Or if the farmer will consent to give a higher price for a good article, which he can mix or adulterate for himself, honourable dealers will spring up, in whom he may as surely confide as we now can in the tinctures of the chemical apothecary, or in the pills, boluses, and conserves which stand ready prepared upon his shelves.*

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* In connection with the cheapening of artificial manures, the analysis of the refuse of manufactories is a subject of much economical importance. Such refuse substances are usually of little money value where they are produced, and yet they may contain substances which will make them valuable to the farmer when properly understood and applied.

At present such substances are largely employed in the manufacture of the lower-priced varieties of artificial manures, but in many cases they are little better than useless additions or adulterations, and therefore a source of disappointment and loss to the farmer who buys the mixtures which contain them. The manure-maker is satisfied with a more or less rude analysis of the refuse he purchases, or with a simple assurance, perhaps, that it contains certain things in certain proportions. He then employs it, perhaps, in perfect good faith in the preparation of his manures, but the practical farmer, in his diminished crops, pays a penalty for the neglect of the preceding parties.

I may illustrate this statement by mentioning a circumstance which occurred to myself within the last three months. A prepared manure was sent to me by the manufacturer for an analysis and opinion as to its value. It was found to contain, among other deficiencies, only about half a per cent. of phosphoric acid. My analysis and opinion were of course both unfavourable. The reply of the manure-maker was, that he used the refuse of a certain manufactory to supply the phosphates, and that he bought this refuse for the purpose, on the faith of an analysis made by myself, and furnished to them by the manufacturer. Of this analysis a copy was sent to me, and it proved to be one made in my laboratory *three years before, for another person, and of a substance produced at another manufactory*, and which analysis had led to an improvement in the manufactory by which the refuse was altered. This refuse did not itself contain more than 1 or 2 per cent. of phosphoric acid, and could not therefore supply it in sufficient quantity to a manure.

Before such refuse matters can be used with honesty by the manure-maker, and with profit by the consumer, we must ascertain not only the exact composition of particular samples, but the average general composition of the refuse, and that this composition does not alter from week to week with the methods or manipulation which attend its production. When these things are known, the manufacturer will be able to judge how far they can with propriety be employed as ingredients of a mixed manure which, to produce constant and uniform effects, must be possessed of a uniform and constant composition.

I would venture also to suggest to all professional chemists, as a duty they owe to the practical farmer, that they should give no written recommendation of an artificial manure, nor allow any such to be published in their names, without first ascertaining, in addition to the composition of the samples sent to them for analysis, the kind of materials employed in the manufacture, the quantities in which they are mixed, the mode of

*Third.*—I have dwelt thus long on the experimental and directly practical part of our progress, as it is the one which most plainly bears upon the profitable prosecution of the agricultural art. But it is, in reality, no less important to inquire what progress we have made in correcting our theoretical opinions, and in fixing upon a surer basis the explanations of rural phenomena which we are called upon to give. That our position in regard to agricultural theory has considerably improved during the last five years will be made plain to you by a few examples. Thus—

*a.* It is known that the bodies of animals contain much nitrogen. This nitrogen they obtain from their food, and this food is all of vegetable origin; for though man or the lion may devour the ox, the sheep, the goat, &c., yet these animals live solely on the herbage which springs from the soil. Now vegetable food is believed to be more valuable for the production and support of those parts of animals which contain nitrogen, in proportion as the per-centage of nitrogen present in itself is greater. It comes nearer to the composition of the animal parts themselves. It has also been long received as a practical truth that the proportion of nitrogen in wheat and other kinds of grain was very much under the control of the cultivator—that by a proper adjustment of the quantity and quality of the manure he could halve or double, at pleasure, the per-centage of nitrogen contained in his crops of corn. Numerous experiments and analyses, supposed to be carefully made, and therefore satisfactory, appeared to have proved this; and you may have heard this fact urged by less cautious persons as a proof of the dominion which chemical research has already given us over the operations of vegetable nature.

But this opinion has not borne the test of rigid experimental and chemical criticism. You will find doubts thrown upon it in my earliest agricultural writings; and experiments and analyses published by myself, by Schlossberger, and by Mr. Lawes, appear to justify us in banishing it altogether from our books. The correction in this case has arisen not so much from better-made field experiments as from more skilfully conducted analyses. After the experimental crops are gathered they must be analysed, and it was incorrect analysis which gave countenance to the opinion I have mentioned. If you consider how much the

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mixture, and above all, the skill and good faith of the manufacturer. Without a knowledge of all this the chemist cannot fairly judge how far the sample he has examined truly represents the whole, and what probability there is that the manure, made at different times, will possess a constant and uniform composition, and can therefore be safely recommended to the rent-paying farmer.

prevalence of this opinion was fitted to modify agricultural practice in the matter of manuring, you will perceive a little not only of the practical value of chemical analyses generally, but how especially necessary the application of the highest analytical skill really is to any sure progress in scientific agriculture.

Did time permit, I might here, in connexion with this topic, satisfy you of the vast amount of work which chemical analysis has yet to do for the art of culture. It is conceded that the proportion of nitrogen in all our crops varies, and it is at present believed that their nutritive value varies accordingly; but the removal of a wrong opinion as to the cause of this variation, and the extent of our power over it, does not directly lead us to the right one. We have, in fact, still to inquire what are the limits of this variation in regard to every crop we grow—how it is affected by variety of seed, by climate, by manure, by soil, by mode of husbandry, by period of growth, by time of cutting or gathering, and many other circumstances. I can assure you that ten long and laborious lives will be insufficient to complete the researches which this one branch of the subject demands.*

I should, however, be guilty of a serious omission were I to pass unnoticed in this place a paper, experimental and analytical, on the growth of turnips, by Mr. Lawes, which was published in a recent part of the Journal of this Society (vol. viii. p. 494). Of this paper, for reasons which may be gathered from what I have stated in the previous part of this lecture, I consider the analytical of more importance than the experimental part, and among the analyses those to be of the most interest which indicate the proportions of nitrogen contained in the turnip when aided in its growth by different manures. From these the general conclusion appears to be that where a field is in a condition to produce an average crop of turnips, the proportion of nitrogen in the crop may be increased by an application of manures containing nitrogen.† According to Mr. Lawes's results, the proportion above what is contained in turnips raised by means of farm-yard manure, may, by such application, be doubled. This result, as it stands, is very valuable and very interesting both in itself and

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* For a sketch of some of the practical consequences to which such researches should lead, see two pamphlets by Sir George Mackenzie, Bart., entitled 'Brief Remarks on the Growth of Wheat for Seed,' and 'A short Plea for the Advancement of Scottish Husbandry by Science.'

† I do not enter into the refinement which Mr. Lawes endeavours to establish between the action of sulphate of ammonia and rape cake applied singly or together. It is a pity to spoil good and fair conclusions by the introduction of this and other doubtful refinements which are to be found in Mr. Lawes's papers, which are really valuable, not only for what they establish, but more so for what they suggest in the way of further research both in the field and in the laboratory.

as an addition to our theoretical probabilities; but it does not afford us alone any sure ground to rest or even safely to speculate upon. It suggests still further and more extended inquiries into the nature of the circumstances by which this proportion of nitrogen is made to vary, the extent to which the variation takes place, and the power of the cultivator to control and benefit by it. And so it is with all our best results, they give us a foothold by means of which we may take another stride, but rarely a space broad enough on which we can stand and rest.

*b.* Another opinion in regard to the nitrogen of plants which has also had much currency, is, that plants derive all they contain from the ammonia of the atmosphere, and that they take it up only in the form of ammonia. This opinion was so contrary to the oldest and most common experience of practical men of all grades of intelligence in the raising of their crops, that nothing but the announcement of it in the form of an undoubted law could have secured it any degree of permanent consideration even among scientific men. As it was, sanguine young persons, chiefly such as were unfamiliar with practice, took it up and warmly maintained it both in this country and abroad. A calm consideration of facts, however, is gradually removing this notion from the public mind, and another year or two will banish it from our books.

*c.* A third opinion adopted by many, and extensively acted upon by some, is, that plants obtain all their organic matter directly from the air, and derive, and therefore require, only mineral matter from the soil.* Contrary as this is also to old experience, it obtained a very general acceptation only a few years ago. Field experiments were made, and results published, which seemed to confirm it.† People began to burn their bones in

* "The crops on a field diminish or increase in exact proportion to the diminution or increase of the mineral substances conveyed to it in manure." —Liebig.

† The writers in this Journal were drawn into the vortex, and some of its readers will recollect an able prize essay by Mr. John Hannam, in which it was believed to be demonstrated by experiment, in especial opposition to the opinions stated in my published 'Lectures,' that burned did as much good as unburned bones, and that it was the mineral or earthy matter only to which their fertilizing efficacy was owing. But experiments, as hitherto made and interpreted, may be used to prove either of two contested opinions. Like the evidence taken before a committee of inquiry, you find the materials in it for making out either case as your feelings incline you, though, on carefully comparing the whole, the truth may to unbiassed persons clearly appear.

I have recently been informed that experience in Wiltshire is in favour of the opinion, that burned bones dissolved in sulphuric acid are more efficacious than unburned bones so dissolved, and containing the same weight of mineral matter. I should be obliged to any practical experimenter who would send me precise numerical results upon this point.

order to free them from the hurtful animal matter they contained, and extensive manufactories of purely mineral manures were established, by which vast fortunes in a brief space were expected to be realised.

But this mineral-matter opinion has also received its death-blow, and we are again on the old highway of experience—taking Theory, it is true, into our counsels, appointing him our consulting chemist, but not allowing him to overrule our deliberations, or to persuade us that his atmospheric railway and his magnetic locomotives are better than the tried lines of Hudson and the trustworthy engines of Stephenson.

I might advert to numerous other theoretical opinions, which, though lingering still among us, have been more or less satisfactorily disproved. Such as that the ash of the same plant always contains the same per-centage of oxygen in its bases; that gypsum acts only by fixing ammonia from the atmosphere; that common salt enters and remains as such in plants; that the analysis of soils leads to no useful practical result;* that manures should be prepared in a less soluble form, that the rains may not wash them out of the soil; and so on—but time will not permit me to enter further into detail. It is sufficient to have satisfied you by the above instances, that in the way of correcting our agricultural theory we are also progressing, and within the last few years have made some respectable advances.

*Fourth.* Turn now to the analytical researches in connexion with agriculture which the last five years have carried on in the various laboratories of Europe. Numerous gaps have been filled up, old analyses have been repeated and corrected, and valuable data of various kinds have been accumulating by which our theoretical views are to be amended and widened, and our general husbandry improved. It is true that many of these analyses, like our experiments in the field, have been made without the necessary skill, and without a due attention to all the desirable pre-

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* In this branch of applied science I know of few things more difficult than to give a safe and useful practical interpretation to the numerical results obtained from the analysis of a soil; and I can well understand the sources of the opinion that the analysis of a soil is of no use. It requires much knowledge of practical agriculture to see their value or to understand what the numbers indicate. Hence the rash advice, on the one hand, which proceeds so often from young laboratories; and the absolute inability to advise in the matter, which is felt by the clear-headed and experienced chemist on the other. When a really well-instructed chemist ventures to pronounce the minute and rigorous analyses of soils of no use, I only feel regret that the weight of his opinion should be thrown in the way of a means of agricultural improvement, which, if he knew more of practice, he would see was not only largely available but in many cases almost indispensable to a safe expenditure of money upon the land.

cautions; but we are thankful for them as they are. They have prepared the way for more unexceptionable results, and have indicated new lines of research and new fields of inquiry. They have suggested new questions to be asked of Nature, and, like all real advances in knowledge, instead of in any way completing the branch of science they elucidate, they have only made the nakedness of the country more apparent, and widened the horizon we have yet to explore.

And while on this subject I ought not to pass without especial notice the labour that has been successfully expended upon this department in our own island through the instrumentality of this Society, and of the two Societies in Scotland, within whose province it more or less particularly comes. For several years this Society (The Royal Agricultural Society of England) has devoted an annual sum to the examination of the ashes of plants—a wide but definite field in which Professor Way has been induced to labour, and whose valuable contributions to our knowledge upon this subject are recorded in the later parts of the Society's Journal. I trust the Council will not grudge the means of continuing these and similar analytical inquiries, and that the office now held by Mr. Way in connexion with the new English Agricultural Chemistry Association will place still more facilities in his hands for cultivating the less popularly understood departments of this branch of science.*

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* In an interesting paper by the Messrs. Rogers, of the United States, on the action of carbonic acid in decomposing mineral substances, lately published in Silliman's Journal, May, 1848. The authors conclude with the following passage:—

" From the great rapidity with which, according to our experiments, potash and soda and their carbonates, but especially potash and its carbonate, rise in vapour, at a strong red heat, we are persuaded that a large error must be committed in estimating the amount of these materials contained in plants by the results of incineration; and we believe that in not a few cases the quantity obtained is scarcely one half of what really exists in the vegetable mass. The important bearing of this consideration upon the late numerous and elaborate analyses of ashes should, we think, claim the special attention of chemists. Indeed, it seems a little remarkable that the source of error here referred to has not already been brought to the notice of analysts, as likely to modify materially their results." I think it right to notice this paragraph for the purpose of adding a word in behalf of our English analyses. The remarks of the Messrs. Rogers are certainly applicable to the Giessen method of burning vegetable substances in Hessian crucibles; but I am not aware that any respectable chemist in Britain either advocates or follows so rude a method. For ten years that ash determinations and analyses have been made in my laboratory, vegetable substances have invariably been burned in the open air at a low, scarcely a red, heat over a gas lamp, usually in open platinum capsules, and only rarely in crucibles. Any one who considers for a moment that alkaline chlorides occur in the ashes of plants, and how easily these, and especially common salt, are volatilized, will see that no ash, which is not prepared at a low temperature, can be expected to contain all the alkaline

In Scotland the Highland Society has perhaps for a longer period devoted sums of money to chemical agriculture, but it has not hitherto seen fit to enlarge its support in proportion to the increased importance of the subject. Long the only leading body in the island in promoting agricultural improvement, this Society has perhaps—for I would speak with becoming hesitation and respect of a Society which has done so much good—scarcely as yet become reconciled to take a second place in the wake of this greater though younger Society, to be influenced by its movements or to be guided by its example. Steady rivalry, however, tells on all; and while you have been not unstimulated by its proceedings, I may say that the Highland Society is now taking a fresh start, and that we of the English Society must work hard and train well, or we may come in second at the next agricultural Derby.

But the analytical, and what I may call the protectionist department of scientific agriculture, has been zealously supported by another Scottish society, the Agricultural Chemistry Association. Having been myself the chemical officer of that association from its commencement, I will merely state, that during the four years and a half that have since elapsed, upwards of two thousand analyses have been made in its laboratory, and nearly four thousand reports and letters of advice have been written to its members. In carrying out its several objects, it has during the same period expended nearly five thousand pounds. You may fairly suppose, therefore, that it has been instrumental in a very considerable degree both in filling up those gaps in our analytical knowledge to which I am at present more especially referring, and in diffusing existing scientific information among the rural population of Scotland.

Some of you are probably aware that the establishment of the Agricultural Chemistry Association of Scotland was only an experiment, which its members agreed to carry on for five years, that is till the November of the present year. The undisputed good of various kinds which the society has done, has given rise to a wish on the part of some that its objects, and in fact that the whole society should in future be incorporated with the Highland and Agricultural Society. I am unwilling to form a hasty judgment in regard to this union; but I confess, that looking solely to the interests of scientific agriculture, I think they are likely to suffer by the proposed amalgamation. Experience, I think, will prove that the entire field of agricultural knowledge cannot be

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matter of the plant. At temperatures far below that at which carbonate of potash volatilizes, great loss may occur from the escape of common salt. All this the Messrs. Rogers might have learned from my friend and late pupil, Professor Norton, of Yale College, whose analysis of oats cannot be unknown to them.

fully occupied and cultivated by one society, or adequately superintended by the same directing body. Among those who willingly support the general objects of our agricultural societies, there are many who feel no interest in, and have no wish to promote the purely scientific or chemical branch. These persons will always be a clog upon the wheels of those who are more zealous for this department, and will stand in the way of the appropriation of means from the general fund for the special encouragement of it.

There is, therefore, in a separate society, the advantage which experience has so often shown to accompany the possession of a special secretary* and board of managers, united in desires and in sympathies, zealous for one object only, pushing it forward as their exclusive duty, and pressing alike now on one another, now on their working officers, and now on the public. Undivided by other claims on their time, their energy, or their resources, I think the cause of scientific agriculture would be surer to progress, and safer in the hands of such an independent body.

It is impossible, however, that a more direct patronage of this branch on the part of the Highland Society can lead to anything but good in the end. The very acknowledgment of its importance which the present movement on their part implies, and the publications and discussions to which it has led, are themselves an important help towards its advance.

I need not trouble you with any detail as to the greater extent to which other branches of science are now made to contribute to the advancement of agriculture. Ten years have scarcely elapsed since the general relations of geology to agriculture were first systematically pointed out,—yet you all know how close and interesting, and generally intelligible that relation has become, since the discovery of the fossil phosphate of lime in the marls of the green-sand and the crag, in quantities which admit of their being economically collected for agricultural purposes.† Veget-

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* What amount of encouragement, for example, or of support to be derived from a direct union with the Royal Agricultural Society, which some have proposed, could compensate to the English Agricultural Chemistry Association for the loss of the special services of their Honorary Secretary, Mr. Huxtable?

† This abundance of phosphates in our marls should also occur in some of our limestones. I have had many examined lately with that view; and while in the magnesian limestones of the county of Durham I have hitherto found only 0·015 to 0·07 per cent. of tribasic phosphate of lime; I have from one blue mountain limestone from Lanarkshire, obtained as much as 1·39 per cent, and in the burned lime as it comes from the kiln 2·33 per cent. A ton of this burned lime, therefore, which is full of fossils, contains as much phosphate of lime as a hundredweight of bones. This phosphate cannot be without its use both in adding to the good effects of the lime and in modifying the apparent action of bones upon land to which such

able and animal physiology, and various branches of physics, as well as botany, zoology, and mechanics, are all now recognised as important auxiliaries to the science and practice of agriculture;—and your own, as well as other journals, show how willingly the cultivators of these various departments are lending you their assistance.

III. It only remains now that I should briefly advert to the third question we proposed to consider. "*What should now be specially done to further or make easy the progress of scientific agriculture?*" This question has no relation to the diffusion, but simply to the means of increasing our knowledge. And upon this point I shall venture to offer only three leading observations.

The first of these has reference to the subject of field experiments, which it becomes every day more difficult to bring up to the exact requirements of our advancing knowledge. Few of those we already possess will bear that searching criticism to which all our sources of certain knowledge must be subjected. Experience seems now to indicate that field experiments which are to furnish us with useful and trustworthy results, are not to be looked for from the unpractised hands and occasional inspection of the practical rent-paying farmer; and that they must henceforth be entrusted to the more instructed guidance and watchful care of the professional experimenter.

You will not understand me as meaning by this, that the practical man should be dissuaded, much less precluded, from the trial of experiments as a most important means of ascertaining how, on his farm, improvements may most efficiently and most economically be made. This interesting and useful tentative method will I hope come every day into more extensive use. I speak only of experiments considered as a source of those sure and indisputable data, by which science is to be carried forward—by which phenomena are to be explained, gaps in our knowledge filled up, and theoretical views tested and improved.

Besides, experiments are eminently suggestive. The result of one points out others it would be desirable to make. But suggestions arising from experiments undertaken for practical purposes, the rent-paying farmer, and even the gentleman farmer, cannot follow up, as if scientific truth were his sole object and time enough were at his disposal. What limited series of results could be more rich in suggestions than that published four years ago by Mr. Pusey (see this Journal, vol. vi. p. 530), in which 13 loads of manure gave as large a crop of beet as 26 loads did, or as 13 loads aided by 7 cwt. of rape dust, or 14 bushels of bones,—while one-

limes have been previously added. These two points I have discussed at some length in Part VIII. of the '*Proceedings of the Agricultural Chemistry Association of Scotland*,' which has just issued from the press.

third was added to the crop, when the 13 loads were assisted by 3 cwt. of guano, or 7 cwt. of woollen rags?* Had Mr. Pusey's mind been disembarrassed of other cares, would he not have followed up in after years these curious results by other experiments, fitted to test their truth, and to explain how they were brought about?

For carrying out such experiments with such views, has any provision hitherto been made? I know of none. I do not say this by way of reproach to ourselves, since so far as I know, no such provision has hitherto been made in any country. Model farms, which in many places exist, have not hitherto contemplated this as one of their objects. But it appears to me that the science of agriculture is now retarded by the want of more sure means of interrogating Nature in the field, as well as in the laboratory. It is something for us to be the first to recognise this position of things, and to cast about for means by which the obstacle may be removed.

And how is it to be removed? By what union of will and purpose are land and money, the first requisites, to be obtained? and afterwards, a head secured, to devise experiments which shall lead to definite and useful ends, and hands fitted carefully and accurately to perform them?

In England, where men unite together so readily for every useful object, the answer to these questions ought not to be very difficult; but as it is not my present purpose actually to incite you to exertion in favour of any definite proposition, I content myself with indicating what ought to be, and I am sure by and by will be done, in various parts both of England and America. The suggestion I have ventured to make is certain to be gravely considered by the friends of agricultural improvement.

*Second.* A second point, connected in some degree with these field experiments, and the importance of which is very obvious, is to train up and encourage a race of instructed, conscientious, and honourable manufacturers of artificial manures. This is a matter which really concerns the pockets of all practical men, and it is in their power very much to bring about the desired end, by ceasing to purchase what is merely low in price, and attending more closely to what is good. In addition to the good faith of the maker and dealer, if the practical man had in his hands at the same time an analysis by a trustworthy chemist, and results

* Mr. Pusey's results were as follows:—

| No. | Dung. | Artificial Manure. | Tons of Cleaned Roots per acre. | No. | Dung. | Artificial Manure. | Tons of Cleaned Roots per acre. |
|---|---|---|---|---|---|---|---|
| 1. | 26 loads | . . . . . . | $28\frac{1}{2}$ | 6. | 13 loads | 3 cwt. guano . | 36 |
| 2. | 13 loads | . . . . . . | $27\frac{1}{2}$ | 7. | | 7 cwt. rape . . | $20\frac{1}{2}$ |
| 3. | 13 loads | 17 cwt. rape-dust | 27 | 8. | | 14 bush. bones . | 20 |
| 4. | 13 loads | 14 bush. bone-dust | 26 | 9. | | 3 cwt. guano . | $20\frac{1}{2}$ |
| 5. | 13 loads | 7 cwt. rags . . | 36 | 10. | Nothing | . . . . . . | $15\frac{1}{2}$ |

obtained in a large trial-garden conducted by competent persons, to guide him, his chances of loss would be greatly diminished. The adoption of such precautions would besides be a great boon to the honourable dealer, while it would help forward in no inconsiderable degree that branch of chemical physiology which embraces the effects produced by mixtures of known and varied composition on different crops, in different circumstances and on different soils.

*Third.* But I pass from this, in order that I may devote the small remainder of our time to the third observation I wish to bring before you. And I venture to propose it to an audience of practical farmers and of the patrons of farming, only because I know how much higher a tone of mind has of late years begun to be awakened among them, and how much fuller a sense of the importance of scientific knowledge even to them, and how much clearer a conviction of its money value to the art they live by.

To make the field experiments of greater value, analytical researches in connection with them will often be required. These will best be carried on in the neighbourhood of the trial-garden, or in a laboratory connected with it. As may be gathered from what has already been stated, no theory can be propounded which will not require or suggest experiment in the field, and no secure forward step can be made in our knowledge which is not based upon actual trial. Independent analytical researches also require to be prosecuted, to aid or test which field experiments may not be immediately necessary, but which would be conducted under the most favourable circumstances, were the opportunity at hand of instituting such trials when they are considered desirable.

I might here indicate many important lines of research in which the conjunction of the field and the laboratory would be likely to lead to results of importance to practice. Thus :—

*a.* The states in which their mineral and organic constituents exist in living plants is an inquiry of much importance, which has scarcely yet been asked of a single cultivated plant, and to which it will require many years of minute and careful labour to obtain clear and definite replies. In what state of chemical combination and of mechanical aggregation do they exist in different parts of the plant? How much in a soluble state in the sap? Of what kind? What purpose does it serve? Is it merely disposing other matter to form fixed parts of the plant, or is it itself on the way to build up such parts? How much of the mineral matter present in the solid, insoluble parts, is necessary to their existence?—how much is foreign unorganized matter?—how much actually indicative of disease?

The study of the ash of plants tells us nothing of the nature or functions of what is burned away—whether it be of an acid or an alkaline nature. And yet these are all of much importance. The

proportion of mineral acids and alkalies in plants varies. But they contain organic acids* and alkalies. Have these mineral and organic substances any relation to each other in quantity? Do they perform the same general functions? Can they take the place of each other in whole or in part? When mineral acids or bases are scarce, can organic acids and bases be produced or taken up in their stead, so as to form a healthy plant? If so, what influence has soil or culture upon this, and how far does this replacement of mineral by organic matter affect the nutritive qualities of the produce?

*b*. Again, in what states of chemical combination the food enters into the roots of plants is a question the immediate bearing of which upon practice you can readily perceive. In what states *can* the different kinds of food enter?—in what states is it best for the plant that they should enter?—and what is the influence of circumstances in bringing them into these states? Of all these we know as yet almost nothing but what rests on bare analogy.† The results of direct experiment are almost entirely wanting.

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* Lime is combined with quinic acid in the China bark, with oxalic acid in the lichens and cacti, with tartaric acid in the grape, and with citric acid in the lemon. Potash is combined with citric acid in the lemon, tartaric acid in the grape, malic acid in the gooseberry, oxalic acid in the sorrel, and so on.

† It is not easy for the common order of practical men at once to see how refined analytical investigations or apparently abstruse theoretical speculations can have any direct application to practical agriculture: and yet there is hardly a new speculation in organic chemistry which has not some bearing upon the physiology of plants and a connection therefore more or less remote with their profitable culture. I will give an illustration.

A very ingenious, and as it appears to me a not improbable, view of the constitution of those organic acids which occur in plants, has recently been advanced by Frankland and Kolbe, that they consist, namely, of oxalic acid in combination with a radical consisting of carbon and hydrogen only, and having the form generally of the radicals of the alcohols.

Now plants absorb carbonic acid by their leaves, and give off in return nearly as much oxygen as the carbonic acid contains. But the nature of the decomposition by which this evolution of oxygen is effected is perfectly unknown to us.

We know that plants contain oxalic acid, and we can understand that if carbonic acid lose one-fourth of its oxygen it is converted into oxalic acid. The production of this acid in this way, in the leaf, would require the exertion of less energy, if I may so speak, on the part of the chemical rays in the sunbeam, and consequently less time than the separation of the whole of the oxygen from the carbonic acid.

Now if this acid when formed unite in the sap with some radical, consisting only of carbon and hydrogen, to form either the other acids which occur in plants or the indifferent substances, cellulose, dextrin, starch, and sugar, which are always present in them, then this carbo-hydrogen compound may have its origin either from the root or from the leaf.

If it be formed by or in the leaf, then the burden is laid upon the leaf and upon the rays of light which fall upon it, of decomposing both carbonic acid and water to produce this radical, in addition to that of producing the

*c.* Intimately connected with this inquiry is the important one as to the state in which it is the most profitable or economical to apply this or that substance to the soil, so as in the greatest degree

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oxalic acid as above explained. More time consequently would be demanded, and growth we should expect would be less rapid on this supposition than if the required radical were produced or prepared by some other agency, or were obtained directly from the root.

Suppose that the ascending sap brings up towards the leaf substances poor in oxygen, and we have a portion of the work already performed, and the growth of the plant may in consequence be more rapid.

Now the organic matter of the soil is characterised by the presence of rather less oxygen in proportion to its carbon and hydrogen than is contained in the recent substance of plants; and the processes of fermentation, &c. by which manures are prepared in the farm-yard are all so many methods by which the proportion of oxygen contained in its vegetable matter is lessened.

This is all in favour of the view that the soil and root contribute to the growth of plants by lessening the labour of the leaves,—by providing substances which contain less oxygen to combine with those which enter by the leaf and contain much. Could we not, therefore, aid the growth further by feeding the roots with substances which contain no oxygen at all? Ammonia which contains none is much used, and with advantage, though the principal part of its useful action is generally ascribed to the nitrogen it contains.

But in those parts of India where petroleum wells abound, this substance is said to be used as a manure for the date tree, and among ourselves coal tar has been applied with advantage to our common crops. Is it unreasonable, therefore, to suppose that turpentine and naphtha-like substances may be employed profitably as manures? A trial of them is suggested by the above theory; and should such trials lead to no profitable result, yet other trials suggested by such views may, and thus practical agriculture will appear to be promoted by the most refined speculations of the laboratory and closet.

The reader will perceive that the very idea of such things as I have mentioned being useful to plants, is entirely opposed to the view which ascribes to the organic matter of the soil the function of supplying carbonic acid only to the roots of plants. But supposing we received such a view as the most consistent with our present knowledge, which I do not think it is, this should not prevent us from following up any new idea, or from giving a fair experimental trial to the suggestions to which new theoretical views may give rise.

We do not understand very well as yet how whale oil and whale blubber, and other fatty matters, form good manures, and yet some of our Lincolnshire friends find the purchase of oil for the manufacture of composts for their turnip-crops a source of profit. May not the use of oil, of petroleum and of coal tar all find their explanation in some theoretical view similar to that stated in this note, and does this view not fairly suggest the propriety of further trials with similar substances?

I give the above, the reader will remember, not as a statement of opinion, but as an illustration only of the way in which theoretical views and researches connect themselves with the profitable practice and with the extension of the agricultural art. I might have adduced an easier and simpler one, but I have purposely selected a theoretical speculation, which at first sight appears as far removed as possible from anything like a practical application to agriculture.

to benefit this or that crop. How far, also, ought the physical or mechanical condition and chemical composition of the soil to modify this state? At what period of the year or of the plants' growth are substances best applied? Are they best laid on all at once, or at successive periods? On none of these points have we as yet any clear scientific information; and you see at once that the conjoined aid of both field and laboratory will be necessary if we are ever to obtain it.

*d.* But more important, if possible, still are the questions which remain unresolved in regard to the nitrogen of plants. What are the natural sources of all the nitrogen which plants require? How much do they need? What functions does it perform in their interior? How much of what enters remains in them, and how much escapes again into the air from their leaves? These are all questions of an important practical bearing, to the solution of which recent observations, both in the field* and in the laboratory, impart a higher degree of importance than we were previously prepared to attach to them. Let me explain in part how this arises.

Nitrogen is acknowledged to be an important part of the food of plants. It contributes to the formation of those substances (protein compounds) upon which the production of muscle in animals is supposed to depend.

The nitrogen which enters into plants has been thought to remain for the greater part within them, and to be gathered in the crop, in the form of these muscle-producing ingredients. But recent experiments made in the United States of America by Professor Draper have shown that plants are constantly giving off nitrogen from their leaves in large quantities into the air, and it appears probable that of the nitrogen which enters their roots only a small proportion remains at last in the full-grown plant compared with what is thus discharged into the atmosphere.

If this be so, you will see, *first,* that plants must require a great deal more of this elementary body in their food than has hitherto been supposed; and, *secondly*, that its combinations must perform in the plant very different functions, or more numerous ones, than had previously been ascribed to it. A thousand pounds of the resources of practical agriculture would be economically spent, could they be made to clear up this one important subject of inquiry only.†

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* See especially those of Mr. Lawes upon wheat in the eighth volume of this Journal, part i., and the speculations he has hazarded in connection with them.

† A practical application of the kind of knowledge to be sought for by this inquiry is seen in the experiments of Mr. Pusey, quoted in a previous note, in which guano and rags added largely to the crop of beet where bone and rape-dust failed, and in regard to which Mr. Pusey suggested that pro-

*e.* Another function of the leaf opens up in like manner a large field of important investigation. From the pores of the leaves, odoriferous and other vapours, as well as liquids, exude. Need I remind you of the odour of a turnip field when the bulbs have begun to form? This and similar odours are due to the escape of volatile vapours from the leaves, which we have not yet sought to arrest or examine. The liquids which exude from leaves are no doubt various as the odours—their differences depending mainly upon the nature and the age of the plant. But there is reason to believe that they rarely consist of pure water. They hold in solution appreciable quantities of organic and saline matters, which, as the water evaporates from the leaf, remain behind upon its surface, or in its pores. These the rain washes off, and carries back to the soil; and this is one of the destined functions of the rain in refreshing the growing plant. What are the substances which the plant thus discharges from its leaves? What is their function in the plant? Are they indications of health or of disease? In what form do they enter its roots? Are they necessary to the plant, and ought they, therefore, to be added to the soil? Are they unnecessary, and ought they to be carefully withheld? In regard to these points, the practical tendency of which is plain, I believe, old as agriculture is, a single precise experiment has never yet been made.

*f.* I offer you only one other illustration. You have all heard of the infusorial animals of Ehrenberg—those minute creatures which the oxy-hydrogen microscope shows to be swarming in a drop of stagnant water. These animals abound wherever water and decaying vegetable matter exist together. They abound in many of our soils. Do they not abound in all? If not in all, then in what soils are they most abundant? Do they, like larger insects, prey upon living plants? Have they anything to do with the sickness and death of clover; with the perishing of young corn; with the fingers and toes in turnips? Are they in any way connected with the benefits derived from draining, from naked fallow, and from the various processes by which peat bogs are reclaimed? Here is a hitherto wholly unthought of field of inquiry, rich in promise, the cultivation of which demands the united labours of the open-air experimenter, of the chemist, and of the microscopical zoologist.

I might also draw your attention to the very interesting and

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bably the excess of nitrogen, which he believed both the former substances to contain, might be the cause of their superior action. We may expect from it also a sure explanation, among other facts, of the circumstance that generally on the green-sand land near Newbury, and as far south as Salisbury, and especially in the Vale of Pewsey, the use of bones is not profitable, while woollen rags, at the rate of 10 cwt. an acre, are extensively applied both to the turnip and wheat crops. In the same district, also, nitrate of soda, for the wheat crop, is sold in large quantities.

important relations of light to vegetation, which the inquiries of Hunt, Draper, and Claudet, made in different directions, show to be extensive, important, and likely to reward those who more thoroughly investigate them;—and I might mention also unexplored fields of research in connexion with the feeding of stock, with dairy husbandry, with the growth of wool, &c., all of which it is desirable to enter upon with the united aid of the cultivators of the practical and scientific branches of knowledge which are fitted to throw light upon them.

But who is to undertake the numerous inquiries I have already named? At whose expense? When can they be begun? Some may think that they lie within the province of an agricultural college, and that Cirencester should take them up. But the proper business of a college is to teach—not to investigate: to diffuse existing knowledge the first—to enlarge that knowledge only the second consideration. Or agricultural chemistry associations should embrace them; and, no doubt, did locality, and convenience, and means admit, such bodies might very fitly attempt to overtake them.

I do not enter, however, into the question of how the ends desired may be best attained; my purpose is to suggest materials for after thought and consideration, rather than to lead you to the adoption of any plan of mine. I do not urge you to take up this analytical more than I have done the experimental branch. I indicate it to you as occupying a most prominent place among those measures which ought to be taken, with the view of carrying scientific agriculture straighter and more rapidly forward.

One cannot help feeling a kind of regret in thus indicating to others trains of research it would be so interesting to follow out one's self. It is like discovering to strangers the secret of a hidden treasure we had hoped ourselves to dig up. In this progress of knowledge, and in helping forward and in some measure directing it, there is so great a charm and honour, that, were it possible, with the means and life of one, I should willingly myself attempt to carry forward all I have suggested; and I should scarcely condescend to point out to you what I would myself, for the sake of science, so cheerfully perform. But the life of one man is too short, his means too limited, and his knowledge too confined, to allow of his hoping to see very much progress made by his own hands, under his own immediate direction, or even during his own lifetime. It is something better, therefore, and higher, while we do not cease to labour ourselves, that we should point out the way to others also—enlist the young and the ardent who are springing up around us—awaken the attention and stimulate the labours of experimental philosophers in other countries as well as in our own—and urge upon all to bring a helping hand to the removal of obstacles which stand in the way

of the progress of all, and which especially retard the advancement of an art on which the sustenance of all so materially depends.

As one who, meditating on the shores of an unknown sea, discerns afar off islands looming hazily on the horizon, which he can never hope himself to visit or explore—or as on some brighter day, pictured on the fleecy clouds by the wonderful mirage, unsuspected fleets, or contending armies, or beautiful cities, appear to his admiring eye, which in bodily presence he can scarcely hope to look upon—so, in his glimpses of scientific fields, and subjects inviting but unexplored, and with kindred feelings, must the votary of progressive knowledge remain content to point out to others what he has himself more faintly descried, or seen more brightly pictured in his mind, of philosophic truth, leaving to them the after task of fully unfolding what he has himself been unable to overtake.

That my present address will be the immediate means of stimulating any to this further investigation I do not venture to predict. I know only that in every country there are numerous persons only waiting to be told *what* to do, and *how* to do it best for the public good, and who will forthwith engage heartily, zealously, and with delight, in any honourable and useful work, however laborious it may be.

In the meantime I have to congratulate myself upon having so long retained the willing ear of so large an agricultural audience, and to thank you for having again lent me that courteous attention which I have always and everywhere received from the body to which you belong.

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X.—*Experiment on Australian Barley.* By R. W. Baker, Esq., of Cottesmore.

*March*, 1846.—Received 1 bushel of Australian barley from the Royal Agricultural Society.

*April*, 1846.—Dibbled it over 1 acre of land (after turnips), red loam upon limestone. The crop was injured by hares and rabbits, and a very heavy hail-storm when about ripe. Produce 6 quarters 3 bushels. The remainder of the field, 16 acres of Berkshire barley, produced over 6 quarters per acre. The quantity of seed sown on that part of the field was a little under 3 bushels per acre.

*April*, 1847.—Sowed the whole 6 quarters 3 bushels.

| | Qrs. | Bush. |
|---|---|---|
| From 4 acres produced . . | 30 | 3 |
| From 13 acres produced . . | 65 | 0 |
| | 95 | 3 |

From 1 bushel, sown in 1846, and the produce again sown in 1847, produced 763 bushels. Weight, per sack of 4 bushels, 15 stone 10 lbs. to 15 stone 12 lbs. gross, QUALITY GOOD.

## XI.—*On the Failure of Deep Draining on certain strong Clay Subsoils, with a few Remarks on the Injurious Effect of sinking the Water too far below the Roots of Plants in very Porous, Alluvial, and Peaty Soils.* By WILLIAM BULLOCK WEBSTER.

As I find the system of very deep draining (4 and 5 feet) on strong clay-subsoils is looked upon by many of our members as a practice altogether new, and one likely to lead to very advantageous results, I think it of importance to call their attention to facts which have come under my own notice or which I have collected from others, and which will be found strongly in opposition to such views. Before I do so, however, as I find that the part I have taken in discussions on this question has led to erroneous impressions respecting my opinions on the subject of draining generally, and as I not unfrequently see myself classed among the "shallow drainers," I wish to set myself right with the agricultural public, and to have it distinctly understood that I am not a partizan of either faction, am not a deep, a shallow, or a medium drainer; but consider each of the several practices exclusively advocated by various zealous experimentalists proper to be applied in individual cases. It would greatly simplify medical art, could we find one mode of cure adapted to every constitution and every disease; but though we hear such vaunted, I have no faith in anything professing so much. For deep draining I am strongly an advocate on soils injured by under-water; and on spongy, and some porous soils; but am opposed to the practice of going to a greater depth than 3 feet upon the *very* strong clay subsoils, where the injury is *not* from underwater, but from rain. To guide me in forming that judgment I have had extensive opportunities of observation, which have led me to the strong conviction that this practice is not advisable, first, because (after a time) the water will not find its way to the drains at all; secondly, because if it does so its percolation is usually so slow as not to free the ground from moisture with sufficient readiness to insure the full benefit for agricultural purposes; and thirdly, because even when the percolation is more rapid an effective drainage cannot be accomplished with the drains placed at intervals so wide as to compensate for the extra expense of sinking them to the increased depth. In cases which have come under my notice where the experiments have been tried, I have seen that the land between deep drains at wide intervals was not in so perfect a state for cultivation as that between drains of more moderate depth placed at less distances. The cost of cutting an additional foot deep is very considerable; in many cases it would double the outlay upon digging. I must observe here that, even among those soils which we class together as

strong clays, the conditions arising from local positions and their chemical components are so various, that they cannot all be placed in one category as to the facility or resistance they offer to the percolation of water. Again, in the case of fine rich grass-land on the alluvial, and therefore more pervious soils, I condemn the practice of sinking drains to depths of 4 and 5 feet, as rendering the ground too dry for the roots of grasses—and exposing them to suffer severely in seasons of continued drought. The same objection is applicable, and perhaps in a still stronger degree, to moss or peat lands, excepting where they are thickly covered or mixed with some heavier material, such as clay or marl, that has a tendency to retain the moisture. The system of draining deeply in all these instances has not the novelty claimed for it by its modern advocates, but has been tried years since in many parts of England and abandoned because it was found signally to fail.

Since Elkington, indeed, first drew attention to the full importance of draining, a vast number of experiments have been tried upon all the geological formations of this island; and could we but have before us a fair statement of the entire results, we should be furnished, I believe, with sufficient data for our future guidance.

Almost every system that has in turn been introduced has been attended in some cases with success, and thus has found advocates, and had a fictitious importance for a time attached to it: each one has, on the other hand, in some cases failed; nor is it reasonable to expect like results where conditions are totally different.

The prevailing custom until lately was, no doubt, to put in drains much too shallow. I am perfectly aware of the importance of permitting the water to filtrate through a sufficient depth of soil to leave its valuable properties behind; I know that, under the old system, shallow draining in some cases did harm by carrying away too rapidly the soluble parts of the manure. But whilst it is well to avoid the errors of our predecessors it is advisable to exercise caution lest we fall into mistakes of an opposite kind. A system of drainage can only be tested by its results in quantity and quality of produce, and its permanent efficiency only by the observation of these results through a series of years: for in some cases deep draining has appeared to answer, in the first and second years after laying down the tiles, but has subsequently proved wholly inefficient. The drains upon examination have been discovered to be unimpeded, but the water has ceased to find its way down to them.

We have scarcely had time yet since the re-introduction of deep draining upon those soils to which my objections apply, to be able to determine the permanent value even of experiments

which are apparently attended with success. Conclusions are drawn much too hastily; and in this, as in other matters, persons of sanguine minds generalize upon very inconclusive data. If water is found to run from pipes laid 4 or 5 feet deep the triumph of deep draining is considered complete; the true test, however, is not in the water thrown off, but in the condition in *which the soil is left for agricultural purposes.* The real object in draining should be to put the land in such a condition that all the rain which falls should do good, or at least do no harm; and this first requisite held primarily in view the problem next in importance is to effect this with the nicest adjustment of present and future economy.

Error in new systems is quickly propagated. The person who has reduced theory to practice with real or imaginary success, is proud of his sagacity and ready to proclaim it: he, on the contrary, who has failed, is by no means anxious to call the attention of the world to his mistakes. In our medical journals may be seen weekly accounts of remarkable cures just completed; the members of the therapeutic art do not bring forward with equal eagerness their cases of remarkable homicide. Perhaps, therefore, while so many successful experiments in deep drainage are being pressed upon the public with enthusiasm, I shall not be doing ill service in turning to the other side of the account, and showing that "profit and loss" in the drainage-ledger should have entries as well in the debtor as creditor side. I have for some time devoted much attention to the subject, with a mind open to conviction and an anxious desire to arrive at truth. I have visited and conducted draining operations on almost every geological formation of this country; I have also been in communication with many of the first agriculturists, who have been draining for years soils of every description, both deep and shallow. On my own farm (of about 200 acres) I have tried various experiments. In one field I took equal quantities of land to test the deep against the shallow plan; the soil, a strong brick earth. On part I sunk the drains 4 to 5 feet deep, and placed them at intervals of 40 feet; upon the other portion the drains were 21 feet, and only 2 feet deep. This depth of 2 feet is less than I should have adopted for the regular drainage of the field, but I wished to try extremes against each other. On the deep drains I returned the clay, as the advocates for the deep system state that all water enters from below. These operations were effected last year and during the past winter. The water has been constantly standing between the deep drains, as it is at this time, 29th April; whilst the shallow-drained portion has been in a comparatively dry and healthy state. To this experiment, indeed, I can attach no great importance, as it has been made

only lately, and the results may in some measure be different in another year; yet upon other portions of my land I have drains not exceeding 30 inches, which have acted perfectly for years. In another field I put some deep drains, and returned the clay on the tiles, and found in the spring, when I wanted to roll the wheat with Crosskill's clod-crusher, that on that portion of the field the land was not nearly so dry, and the soil stuck to the roller. I may mention here that a railway cutting through my farm 18 feet deep, drains no more land on each side of it than a drain 3 feet deep.

A neighbour of mine, the Rev. E. Tunson, of Woodlands, had several deep drains put on his farm many years ago. These drains continued open, but they ceased to act, and the land above them became so wet that it had to be redrained. The same may be seen on the estate of H. Holloway, Esq., at Marchwood; and also the Park at Norris Castle, Isle of Wight, where, though thousands have been expended in deep drains for springs, the soil being retentive, surface-draining is more wanted. *This* would not have been the case had the soil been of a porous nature: it arose from the fact that the water could not percolate through the clay-bed to the required depth. I found numerous other deep drains quite unobstructed, yet the land about them so wet that we did not know it had been drained; for instance, at Thornhill near Southampton. And I remember Lord Portman telling me of a similar instance on an estate of his near Blandford.

I wish to point to cases of the failure of deep drains, under those circumstances in which I have expressed myself opposed to their use, in many parts of England, and on various geological formations; and I may as well, therefore, arrange them in something of geographical order. From Hampshire, then, we will turn eastward and pass into Kent. We have heard much of the deep-draining on the weald-clay; like most other clays it varies greatly in its nature; in some places it is of a very tenacious character on the surface, but as you dig into it, instead of becoming stronger it becomes milder. In this case your drain may have a freer flow of water at 4 feet than at 2 or 3; because the water having, by however slow a process, percolated through the superincumbent mass, does not meet with a more retentive bed of clay at 2 or 3 feet, as on other soils; but in other parts of the weald the arrangement will be found which is common with the clays of the London Basin—the oolite and lias. The section of the ground will then present soils in the following order:—

*Surface.*

The ploughed soil.

A soil partaking of the character of the superincumbent cultivated earth and of the strong clay beneath, and which will admit of percolation.

A bed of tenacious clay, not full of water, but almost impervious, being the cause of the wetness of the land, rain-water not going into it.

In this case the water will be found just above the tenacious clay, and it is a great error in draining to go deeper into this than to bury your tile or pipe with safety, unless this mass of retentive clay is within a foot or two of the surface; then place your drain 30 inches or 3 feet, filling that portion in the retentive clay with some porous material, such as a grass sod or soil, for the purpose of at any future time deepening your soil by subsoil ploughing, trenching, &c. In proof that deep draining will not in all cases answer upon the weald clay, I quote the following letter :—

*Staplehurst, January* 30, 1847.

DEAR SIR,—In reply to your favour of the 25th inst., I beg to say that the land in my occupation is for the most part very stiff, wet, and flat, consequently subjected frequently to serious injury from wet seasons, to obviate which I have been draining about 200 acres on the farm upon which I reside, besides small quantities of other farms, perhaps altogether rather more than 300 acres, nearly the whole of which has been done on the clay soils of the Weald of Kent. I commenced by going 2½ feet deep, and found it answer my expectations fully. Subsequent to this an opinion began to be entertained that deeper drains would be much more beneficial for our clays; many advocated it and adopted it, some of which is said to have been successful, although I must confess I have never myself been an eye-witness to a single case in which *deep draining* has been successful upon *wet stiff clays*. Although my employment as a land agent and valuer gives me the greatest possible opportunity for observation, the general prevalence of the opinion induced me to go a little deeper than before, and in one field of between 6 and 7 acres, at the earnest request of my deep draining friends, I put in the drains near 4 feet deep and 33 feet apart 4 years ago (this was in 1843): in consequence of the stiffness of the soil, being nearly all strong clay, it proved an entire failure; and I have this winter drained it again about 30 inches deep, and am fully persuaded that depth in land like mine is much the best, being wet from the rain that falls upon it, and not subject to springs. I have no doubt the water would after a time pass down to the deeper drain; but it would do great injury before doing so. I should recommend the deep drains upon porous soils and land subject to springs, but on those soils on which there are no springs, which are wet from rain that falls on them only, and are not porous, it is next to madness, in my opinion, to drain them deep, say 4 or 5 feet, as some contend for. Yours, &c. WILLIAM BARNES.

W. B. Webster, Esq., &c. &c.

Turning northward, we will pause at Norfolk to record the opinion upon the subject of draining deep upon strong clay of

one of the best farmers in that county, Charles Etheredge, Esq., of Sturston, Harleston. He writes thus:—

> You know all round my heavy land here I have ditches from $3\frac{1}{2}$ to 5 feet deep, and such ditches are general throughout the same land in Norfolk and Suffolk, on farms well cultivated, and they are generally kept clean with a free access for the water. Still we find it necessary when our drains are parallel to these ditches, to make them not exceeding $22\frac{1}{2}$ feet apart from them. I do not mean to say that if drains $3\frac{1}{2}$ to 4 feet deep were put 40 feet apart on these soils, the centre between the two would not be improved by them. I think it would, but certainly in a much less degree than if they were 22 feet apart and 30 inches deep; and there would be another great objection on clay interspersed with flint and chalk boulders in the digging. I find that after $2\frac{1}{2}$ feet of soil has been removed, the next 14 to 16 inches have cost 6*d.* to 8*d.* per rod of $5\frac{1}{2}$ yards. It is not at all uncommon to see a clay pit stand with water, within 2 feet of the surface, within from 3 to 6 yards of a 4 feet ditch: where I have been draining 4 feet deep, the subsoil is interspersed with sand pockets, and a much greater width between the drains may be allowed; but there can be no rule. Finally, my great object in draining is not only to do it effectually but rapidly. You must in no instance be satisfied to have your soil saturated with water till your sluggish drains draw it off; it must go off as quickly as it falls, or your drainage will be neither effectual nor permanent. Yours, &c. C. ETHEREDGE.
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> W. B. Webster, Esq., &c. &c.

Mr. Nesbitt (the-well known agricultural chemist), in the discussion which took place at the London Farmer Club on the 9th of March, in the present year, in stating his opinion that upon some soils deep drainage was most effective, whilst upon others a shallower drainage ought to be adopted, referred to Mr. Thompson in this county (I think he said), as having tried deep draining on his farm, and having been compelled, after a fair trial, to abandon it, not finding it successful on that soil. To quote instances of the success of an opposite system is no proof that deep draining might not likewise produce advantages; yet where experience has proved the value of the one, it is hardly wise to engage in large operations on an experimental plan that can hardly produce fairer results, and may be attended with disappointment and waste of expenditure. It has been by draining at depths of 30 and 36 inches, and at distances of 18 to 24 feet, that the farms of Mr. Harvey, Mr. Gidney, and many others on the clay lands round Harleston, in the south-eastern part of this county, have been brought into their present admirable condition. In Lincolnshire I have gone over thousands of acres of the fens; and I found the fact testified to by most of the best farmers, that if the water in the ditches or dikes is taken off to a level below 3 feet, the grass-land in dry summers is decidedly injured. The following letter from a farmer of this county will show that deep draining is not so novel a practice as some of its modern advocates assert:—

*Swanton, near Folkingham, February* 17, 1847.

SIR,—I will answer your postscript first. My opinion is decidedly against deep draining on strong clay land. The parish where I reside is composed of part field and part fen; a great portion of the field land is strong clay. Several years ago when we first commenced draining with tiles, they were put in deep, 3 feet 6 inches, and the lands being wide with high ridges were thrown down so as to make the surface level: after a short time the land became so solid, that surface water could not get down to the drains, and it remained on the land in a stagnant state, to the manifest injury of the growing crop, and the land had to be top-gripped in the same manner as if it had not been underdrained, or nearly so. We have now altered our plan, and now rarely drain deeper than 18 to 24 inches; the tiles we invariably cover with a small portion of stubble, and then with the soil dug out, but never ram the earth on the drains. There is an inclination to drain deep in *porous soils*, where the fall will allow it.

Yours, &c. W. MOORE.

W. B. Webster, Esq., &c. &c.

In Yorkshire the greater portion of the soil being the new red sandstone is naturally rather porous, and of a character fitted for deep drainage; and on the coal measures near Rotherham there is in places found much underwater, which, as it generally comes from a higher level, and constantly forcing its way to the surface, requires to be removed, or seriously damages the crops. Very different, however, are the coal formations of Durham and Northumberland. I remember going for eight miles underground (in a coal-pit), in the neighbourhood of Newcastle-on-Tyne, where the soil above was of a strong nature, such as to require draining at about 30 inches deep, yet where but little of the surface water percolated to the mine; yet the percolation of water is often a source of the greatest annoyance in mines of great depth, where the superposed strata consist of mild clays and porous rocks. The following is a letter of the well-known Mr. Stephenson, of Throckley, near Newcastle-on-Tyne:—

*Throckley House, March* 1, 1847.

DEAR SIR,—I received your letter. Not having sufficient experience, I cannot answer it respecting 40 feet apart. I should doubt the result being satisfactory. In 1845 I drained a field 30 acres, 10 yards apart and 3 feet deep, strong clay, which has given me every satisfaction. I had a splendid crop of wheat upon it last year, and the whole field appears perfectly dry and fit for every purpose.

I have drained 60 acres since October 20 feet apart, 30 inches deep, and *am perfectly* satisfied it is the best distance and also depth for strong clays. The effects are astonishing. Yours, &c. W. STEPHENSON.

W. B. Webster, Esq., &c. &c.

From such opportunities as I have had of examining the soils of Scotland, I have found reason to believe in that part of the island the clays are generally of a less retentive nature than what are common in the south; and evidence of this is seen in the fact that the tread of the horses in ploughing double is not, as on many of our English clays, injurious to the land. This milder

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prevailing character of the aluminous soils of North Britain may result from so large a portion of the land lying upon the primitive rocks, the materials supplied from the disintegration of which are not of a very cohesive kind, in comparison to some others. It is stated, nevertheless, in the Encyclopædia of Agriculture, "that" (in Scotland) "it was formerly the practice to go 4 feet deep, but that it is now found that a shallower depth and closer drains do much more good."

What said the late S. D. Sterling, of Glenbervie, near Falkirk, who, after trying all kinds of draining for years most extensively, writes to me in 1846, and says—"I do not believe on such land" (the strong clays) "that any increased depth will compensate for a greater distance between the drains."

*Extracts from a meeting of the Highland Society.*

Mr. Dixon, of Saughton Mains, at a discussion held at the Museum of the Highland Agricultural Society, Edinburgh, on Wednesday the 15th of March, 1848, quite agrees with me on the impossibility of fixing on any depth or distance for drains, and although he knew the importance of deep draining on some soils, yet he mentions its failure on others, and says—"After going 3 feet the soil changed to gravel and sand, much water was found, and deep draining answered perfectly at wide intervals; yet in the same county an experiment of the same kind was tried with the opposite result, the *subsoil being a very retentive clay;* here one half a field was drained at the depth of 4 feet and 36 feet apart, and the other half at the depth of 2½ feet and 18 feet apart, and the result was most decidedly in favour of the shallow drains, with an interval of 18 feet between them; the other portion of the field appears only to be half drained." Where instances are quoted of deep drains in clay at wide intervals being successful, we must remember they are only of recent date. I have never been able to find a single instance of a field drained 4 feet deep and 40 feet apart, that had been done for ten years, successful on the strong clay subsoils.

What says Mr. Scott, of Craiglock?—"We are told that on all soils, whether muirland, till, or stiff clay, dry clay, sand, gravel, or moss, a minimum depth of 4 feet is stipulated for, and a minimum distance of 36 feet apart." Upon hard impervious clays I have not been able to thoroughly dry the land with drains at 36 or even 30 feet apart. I have seen the attempt made with drains 4 feet deep, 36, 32, and 30 feet apart; but in *all* these cases the result was unsatisfactory. In all these instances a great quantity of water was carried off by the drains, and the land was much benefited; but still the soil was not brought into that state in which the greatest fertility could be called into operation.

What says Mr. Tinnie, of Swanston?—"Where the subsoil is uniformly retentive I make my drains 18 feet apart and 3 feet deep, and were I to drain the same ground over again I should follow the same course."

Smith of Deanston also instances two failures, one on the property of Sir Ralph Anstruther in Fifeshire, and another on an estate at Coltness, made three years ago, in Lanarkshire: and also says—"I have never seen an instance of thorough draining by deep and distant drains, whilst all over the country you may see land perfectly dried with drains 30 inches deep and 18 to 20 feet apart." Also an experiment had been made by Mr. Hope, of Teulin Barnes, in East Lothian, which went to show that better crops had been raised over the shallower than deep drains. At the

same time Lord William Douglas stated that the turnips on the shallow drained land at Balcaskie weighed about ⅓ heavier than on the other.

I am quite aware that at this meeting instances were brought forward of deep drains being successful, but I am now showing the failure of such drains on retentive clay subsoils, and not going into the question why they have succeeded on certain spots. This I shall be happy to do at some future time.

Returning southward by a western route we will let the moss lands of Lancashire detain us for awhile. What I stated as the opinion drawn from observation among the best farmers of the Lincolnshire fens, is as true of those who cultivate the peaty soils of this county. Thus respecting Rawcliff, the property of Mr. Wilson Ffrance, near Garstang, where upon 1,000 acres of what a few years ago was a bog is now a most thriving tenantry, Mr. Ffrance told me as one of the most familiarly known facts, that deep draining upon that soil is extremely injurious—the land, as moss land, is actually ruined by it. If the soil, indeed, be altered in its texture by the application of clay or marl, it will then bear deeper drainage; but even in that case drains beyond 3 feet are not found advantageous. Testimony to this effect is borne by William Aiton in his valuable treatise on the Cultivation of Moss. "Whenever a moss," he says, "is either by nature or art rendered drier than such furrows or shallow drains would make it, instead of being benefited, it is thereby greatly injured. Proof of this may be seen at every plough moss." And again, at p. 197, "At Paisley, where a number of deep furrows had been cut, they were found to be hurtful—they were filled up." And in another place: "All the moss improvers I have met with have owned to me that they had injured their mosses by making them *too dry;* but none ever could say to me that they found any want of drains where no water stood or stagnated on the surface."

The late William Roscoe, of Liverpool, stated in a letter written to Mr. Aiton, in 1807, that, having undertaken the improvement of a large portion of that moss, he began by cutting drains 5 feet deep, but afterwards changed his plan to drains about 1 foot only, which he said answered as effectually as the larger drains. His letter concluded thus: "My workmen even insist upon it that the shallow drains carry off more water; but this may appear so from the water being confined. In sudden rains they carry off a great quantity, so that the moss is sooner freed from surplus water than any other land, and is now passable in any direction, although it was lately not only difficult, but dangerous to go upon it." Mr. Aiton, as the result of his extensive experience, finishes his remarks by saying, "All future draining (on moss land) beyond a moderate depth ought to be guarded against as the sin of witchcraft." But to leave the moss land and

return to the strong clays, a proof of the obstinacy with which they will retain wet near the surface, without such conditions at a greater depth in the earth as to prevent the escape of the water, could it percolate through the clay, may be seen on the estate of Sir O. Mordaunt, near Warwick. There draining is required, although the subsoil, at a depth of little more than 4 feet, is a dry sandstone.

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|---|
| Soil, 15 inches. |
| Clay, 3 feet. |
| Dry sandstone. |

This is also the case in many other parts of England—the clay resting on dry chalk, sand, and stone. Now if water will freely percolate through 4 feet of stiff clay to reach a line of pipes 30 and 40 feet apart, how is it that it will not reach an absorbent material that spreads eager for more, like a thirsty sponge, beneath the whole of its lower surface? Simply because the clay is not overcharged with water, and does not transmit it.

In Worcestershire deep draining has been tried upon the strong clays of the blue lias with ill success many years ago, as Mr. Bayles, of Prospect House, near Evesham, in that county, has had to redrain land on account of the inefficiency of deep drains. The following is his letter:—

*Prospect House, near Evesham, Worcestershire, January* 31, 1847.

Dear Sir,—I have drained one field over again, owing to its being too deep. The drains are from 3 to 4 feet; the land being strong stiff clay rendered them useless for surface water; the new drains I have put in about 2 feet, and filled them with broken stone or burnt clay. As to my sandy or porous soil, I prefer draining deep. Yours, &c. G. Bayles.

W. B. Webster, Esq., &c. &c.

I have seen similar instances of failure in other estates in the same county, in the vale of Evesham.

I shall add a letter from Mr. Randall (the gentleman who wrote an article on burning clay in a former Journal), likewise of that neighbourhood (although it refers to no case of the failure of deep drains), as it is founded upon experience.

*Chadbury, near Evesham, February* 16, 1847.

Dear Sir,—I can give you my opinion of draining clays for surface water in a very few words: it is that I would not put in pipes at a greater depth than 3 feet, nor less than 2½ feet. This is the result of some experience. I fully consider 2½ feet sufficient. Yours, &c. C. Randall.

W. B. Webster, Esq., &c. &c.

Now if the advantage of deep over shallow draining is so decided in *all* cases, how is it that those who have tried 3 feet do

not altogether abandon 24 and 30 inch drains? The advocates for deep draining upon those strong clays upon which such a system has not been in use, say that it only requires that we should try the experiment in order to be convinced of its superiority: where does the proof of superiority commence? If 4 feet is obviously superior to 3 feet, might we not expect that 3 feet would be in an increasing ratio superior to 2 feet? We find experienced drainers continuing upon strong clays to vary their depth, being guided therein by other local considerations; but if 5 feet draining is to explode 3 feet draining, the latter ought, long ere this, to have put an end to draining at still less depths.

I am able to quote a statement from a gentleman in the neighbouring county of Herefordshire, whose experience has led him to abandon the practice of laying deep drains in stiff clays in favour of those of more moderate depth. The practical basis on which his opinion is founded gives it importance.

*Tarington, near Ledbury, Herefordshire, January* 28, 1847.

With reference to your request as to my opinion of the deep draining on our *stiff* soils, I beg to say, that I have had much practical experience in draining such lands, *formerly* at 5 feet deep, very rarely less than four; but latterly two and a half and three feet. *I am fully convinced* that in dense clay lands 30 to 36 inches is fully as deep as it is profitable to drain, and that a drain at a greater depth will not answer the purpose intended. Where springs exist the case is of course different. I have drained with the best possible effect land at 30 inches deep, where I had previously drained at 5 feet with only a partial effect. Yours, &c. C. A. Mason.

W. B. Webster, Esq., &c. &c.

I think the facts I have brought forward are sufficient to show that deep-draining will not prove successful alike upon all soils and under all conditions. Arguments and opinions unsupported by specific facts are of little comparative value; yet when it is shown that what is called the new system of drainage is not new, but has been tried long ago, great importance must be allowed to attach to its abandonment as evidence of its inefficacy. Elkington testifies to the fact of deep drains having been tried as a means of removing surface-water from strong clay soils in or before his time. No one could be more an advocate for going deep for springs; but, with reference to trying the same plan for draining clay, he says (see his work, by Johnson, p. 137), "In soils that are so tenacious as to retain water on the surface, this method of draining (deep) has been tried, and found entirely to fail." Indeed, throughout, this work, and all others published up to about 1843, condemn going deep in strong clay subsoils.

I have myself inspected many of the works executed by Elkington, and taken up drains put in by him eighty years ago (he began in 1764); and my observations, whether upon the

state of the lands drained by him where no subsequent system had been tried, or on the condition of the drains, went quite to confirm his view.

I will only further quote from old Mr. Tebbet, who made the Duke of Portland's water-meadows (no one will question his sagacity and experience); and is the result of his experience to show that the deeper the drains the more efficient their action? No!

*Mansfield, Nottingham, January* 28, 1847.

Dear Sir,—The underdraining I have directed upon strong clay land I have done in various ways; but the *best* way I have adopted is to put the drains 14 feet apart and 2 feet deep. Some clays will draw 18 to 24 feet apart, and from 2 to 3 feet deep; I have seen a great deal of good done by cutting deep drains for springs 8 and 10 feet deep, and there is much land here that cannot be made dry unless the springs are removed. Yours, &c.

T. Tebbet.

I will not occupy more space in quoting the opinions of persons who, having had sufficient opportunities of witnessing the effects of various depths of drainage, have formed unfavourable conclusions respecting the use of deep drains on strong clay land at wide intervals; though those of old Pearson, the spring-drainer in Essex (see his evidence before the House of Lords); of Smith of Deanston, who first forced upon the public the importance of thorough draining, and did show what could be done in strong land at moderate depths and distances; and of others are before me—these are accessible to the public in other forms. What I have said may, perhaps, be sufficient to excite attention, and set people on their guard against plunging into the expense of a system of drainage which has failed in many instances, and might therefore cause disappointment in many more.

William Bullock Webster.

*Hounsdown, near Southampton, April 29th,* 1848,
*and* 48, *Charing Cross, London.*

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Mr. Webster's statements agree with my own observation, and seem fully to bear out a caution which I suggested two years since as to the risk of draining at a depth exceeding 30 to 36 inches in some of our strong English clays. Where such land lies in high ridges I have found that drains of that depth running along the furrows have been often sufficient at an interval of 30 feet, because the upper parts of the ridges are self-drained by their own shape; and I certainly prefer leaving that undulating surface to the risk of injuring the productiveness of the soil by any sudden attempt at levelling it.—Ph. Pusey.

# THE JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

VOLUME THE NINTH.

PART II.

PRACTICE WITH SCIENCE.

No. XXII.—DECEMBER, 1848.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

LONDON:—Printed by WILLIAM CLOWES and SONS, Stamford Street.

## CONTENTS OF PART II., VOL. IX.

## APPENDIX.

## XII.—*On the Management of Farm-Horses.* By W. C. Spooner.

### Prize Essay.

The great importance of the subject of this Essay cannot for a moment be disputed. The vast amount of capital invested in farm-horses is nearly equal to the annual rent of the land cultivated by them, and the annual cost of keeping these horses is not less than their actual value. Thus if we take the number of acres of *arable* land in England and Wales as 13,100,000, and the rental as 12,000,000*l.*,* we have this large sum as representing the cost of our agricultural horses, and a similar or greater amount as the value of the food they annually consume. Though this may appear a rough method of making our estimate, I believe it to be not very far from the truth. These circumstances are sufficient to demonstrate the national importance of our subject; whilst its individual consequence to agriculturists may be enforced by the fact that not only is a sum nearly equal to the annual rent required for the purchase, and also for the yearly keep of the horse-power on a farm, but it is a constant weight that cannot be shaken off or shifted to other shoulders. In manufacturing operations and in locomotive travelling, steam-power has, from its superior economy, effectually supplanted animal power, but except for the purpose of thrashing it has been found inapplicable for the tillage of land, and still more so for the cartage of corn, hay, and manures.

As therefore horses *must* be kept for these various purposes, it is surely of the utmost importance to understand and to adopt the best and most economical methods of managing them.

The amount of horse-power required on an arable farm must or rather ought, to be regulated by the requirements of spring, turnip, and wheat sowing. Unless a sufficient number is kept to take advantage during these periods of the most suitable weather, so constantly varying in this country, great will be the loss experienced; and on the other hand, if more are kept than the sowing season demands, a heavy expenditure is uselessly incurred.

We take it therefore as our starting-point that the number of horses to be kept on a farm must be regulated by the requirements of the sowing seasons. On this must hinge our whole

* Mr. Middleton, in his Survey of Middlesex, estimated the whole land under tillage in England and Wales at 12,000,000 acres. Since his time a considerable quantity of down and pasture-land has no doubt been broken up; but in reckoning as upwards of 10 per cent. the land thus brought under the dominion of the plough, we are not underrating the march of improvement. It may be useful to add, that the value of the agricultural produce raised on the above has been estimated at about 70,000,000, whilst that from pasture-land has been taken at about 60,000,000.—Author.

subject, and to it must be directed its different divisions as laid down by the Council. It is a drawback upon horse, as compared with steam power, and more particularly as relates to farming operations, that whereas a steam-engine when not in work consumes no fuel and does not waste from wear and tear, a horse must be fed whether he is at work or idle, and thus throughout the winter months, when there is but little work to do, he must be kept in condition in order to perform properly the labours of the spring. It is therefore of imperative importance to keep such horses on a farm as are capable of performing properly a horse's work, for if weak, under-sized, infirm animals are kept, each of which is only capable of doing one-half or three-fourths of a day's work, not only is there the loss of this one-fourth of the day in the busy periods of the year, but an additional number of horses must be kept all the year round. It is only begging the question to say that this infirm horse does by hook or by crook contrive to get through his day's work in the busy periods, for if he is able to do this, then an able-bodied horse is capable of doing, with no extra fatigue, one-fourth more work at least, and it is the fault of the owner if this is not accomplished.

With these preliminary observations we proceed to consider our subject according to the divisions proposed by the Council:—

1. The various breeds.
2. Breeding and rearing.
3. Keeping, whether in stables or the open air.
4. Feeding in different seasons.

### 1. *The various breeds of Cart-horses.*

The conformation of the cart-horse differs from the thorough-bred and other light horses, principally in the construction of the skeleton; not only are the bones actually larger but there is a greater amount of bone in proportion to the muscular system than in other horses; and there is in the heavier breeds such a disposition to form or secrete bone in the system that even before the animal is five years old many of the cartilaginous structures, as, for instance, the cartilages of the foot, become changed into bone; that is, the earthy part of bone, which is principally phosphate of lime, becomes deposited where cartilage only ought to exist. This predisposition to deposit the earth of bone so peculiar to the heavy breeds, is greatly accelerated by concussion or anything indeed which induces chronic or rather sub-acute inflammation. Thus the London pavement is a fertile cause of this disease, so much so that there is scarcely a dray-horse in the metropolis but what has some degree of ossification of the cartilages by the time he reaches six or seven years of age. I have no reason to believe that the food of

heavy horses contains a greater proportion of the earth of bones than that of other horses, but there is unquestionably a greater power of assimilating these earths, so that I doubt not that if the blood of the dray-horse and that of the blood-horse were separately analyzed, a greater amount of the phosphates would be found in the former.

The effect of this redundancy of bony structure in the system is to afford a larger basis on which the superstructure is built. The extremities of the bones which form the joints are more extended, giving a greater power of sustaining weight; not that the bones are actually stronger, but rather the contrary, for in fact no bone can be stronger in proportion to its size than that of the thorough-bred horse: it is hard, firm, and compact, whilst that of the cart-horse is softer and abounds more with fat or marrow. Although the surfaces of the bones which form the joints are larger laterally, yet they do not afford so much extent of motion as in lighter horses, or, in other words, the motions of the joints are more limited.

The larger bony frame possessed by these horses of course affords a corresponding surface for the putting on of flesh as well as a greater capacity for the development of the internal organs. The muscles (or flesh) are more remarkable for their thickness than their length, the former being the cause of *power*, the latter that of *speed*, and the spaces between them are simply filled up by depositions of fat. The frame of the body is distinguished by rotundity and thickness; the fore-legs are wide apart, and the chest broad, but by no means deep as in the long-winded speedy animal. The digestive organs are capacious, and the digestive functions far more powerful than those of the thorough-bred horse, whilst the brain is relatively smaller and the nervous system altogether less developed. We have here the key to the points of the cart-horse. Whilst he should possess all the characteristics of the breed he should be free from extremes. Thus while his back should be short and broad, the body round as a barrel, and consequently wide in the chest, yet the latter point must not be carried to such an extreme as to cause the horse to be a slow walker, for of all the *sins* of the cart-horse this is surely the greatest. An animal whose walk does not exceed 2 miles an hour will scarcely get through half the work in the day that will be accomplished by the free moving horse that can do his 4 miles in the same space of time. So important do I hold it that the cart-horse should be fast in the *only* pace he is required to perform, that I would recommend to the Council of the Royal Agricultural Society, or rather to the stewards of the cattle-yard, that a distance should be measured off, to the extent of some fraction of a mile, in the cattle-yard, so as to afford an easy method of judging of the pace

of cart-stallions in their walk, for I hold it as a point of the utmost importance that a prize should never be awarded to a bad or slow walker, however great his strength or perfect his symmetry may otherwise be.

With these preliminary observations I proceed to consider the various breeds of cart-horses.

The *cart-horse* is not an aboriginal breed in this country, but was imported from the neighbouring continent since the Norman Conquest. Indeed we have reason to believe that the horses employed in the army of William the Conqueror were little better, as respects breeding, than the cart-horse of the present day. As long as armour was in fashion a large massive animal was required to support the enormous weight of the steel-clad knight, and to withstand the ponderous attack of a similar opponent. The half-bred horse was then unknown, and the Barb and the Spanish horse were insufficient in size, so that recourse was had to the large black horse which had been known throughout the fertile plains of Europe from time immemorial, and from which no doubt the greater portion of our cart-horses are descended, for we find that during the reign of the Edwards, repeated importations of these animals took place, and in the time of the Duke of Newcastle, who wrote a work on horses in 1667, there was in this country an established breed of cart-horses.

The most prevailing colour amongst these animals is black, so much so that we recognize a distinct breed under the appellation of the *old black cart-horse*. We scarcely ever find that the thorough-bred horse is of a black colour, whilst it prevails very much amongst the coarser kind of horses. The black cart-horse is pretty generally distributed throughout England, and may indeed be divided into three kinds:—First, the large massive animal reared in the rich marshes and plains of the Midland Counties expressly for the London brewers; secondly, the smaller sized, but still tolerably heavy, kind of horse generally employed for agricultural purposes (a strong compact animal, but slow in his action); and thirdly, a lighter and more active animal, possessing in fact either some admixture of blood of a lighter breed, or being the descendants of the Flanders coach-horses discarded from the carriage to make room for the Cleveland, and welcomed in their more legitimate sphere at the plough-tail.

The *dray-horse* can only be reared in the richest pastures, and is found in the fens of Lincolnshire in the greatest perfection. The breeders usually sell them as two year-old colts, retaining as much as possible mares for their own work and for the purpose of breeding. The purchasers of these colts work them moderately till they are four years old, feeding them well during this period, and indeed, previous to their resale, they are often taken out of

work and actually fatted in loose boxes, almost like oxen for the shambles, in which state they are supposed to please the eye of the London brewers, for whose more particular use these pampered animals are bred. Thus the colt, purchased perhaps for 40*l.*, realizes in the course of two years double this amount, besides working moderately during this period. Thus if the horse does not fall a victim to the various diseases which a redundancy of blood is calculated to induce, he yields an ample profit to his feeder. These ponderous animals are frequently 17 hands high; and their sleek and glossy appearance, as they move majestically through the streets of the metropolis, present one of the most striking sights to the eye of the foreigner. That such large massive animals are really required, or are the most profitable for their peculiar work, is a matter of considerable doubt; however it is a species of pride which has long prevailed among our London brewers, and whilst they continue the premiums in the shape of high prices for these massive animals, the breeding of them will continue a profitable pursuit, and the streets of the metropolis will continue to exhibit the *largest horses in the world.* One great drawback attending this breed is their tendency to weak and convex feet, and to ossifications of the cartilages and the pasterns, the former being the effect of their great weight acting on the soft horn induced by the moist pastures, and the latter to their great predisposition to throw out bone, caused perhaps partly by the large amount of the phosphates taken in their food. Many of these horses are rendered useless by these morbid deposits; which yet are so common that there is scarcely a dray-horse in London but what possesses in some degree these *side-bones,* and in very many instances no injury takes place.

In the improvement of this breed of horses it ought to be an object to diminish, or rather discourage, as much as possible these objectionable qualities to which the breed is naturally so prone.

The large dray-horse is by no means confined to those of a black colour, we have many of a bay, and still more of a brown colour, and also many greys and roans.

There are also very many excellent compact cart-horses more adapted for agricultural purposes, of these various colours, and indeed in general I prefer them to the black cart-horse, as possessing greater activity, cleaner limbs, connected with equal compactness and strength.

I may here observe, that at the meeting of the Royal Agricultural Society at Northampton, where the show of horses was large as well as excellent, there were only two of a black colour, whilst there were many browns, bays, and chesnuts, and most of them worthy of commendation.

It is in the Midland Counties that these horses are principally bred, and though of no peculiar or distinct breed, they offer as favourable specimens of horses adapted for all the various purposes of agriculture as are to be met with anywhere or in any country.

The *Suffolk-Punch* is a well known and much esteemed breed for agricultural purposes, possessing the combination of strength, compactness, and activity more highly than any other breed. It is impossible to trace the origin of these horses; but they have been cultivated in Suffolk for very many years, and were probably once employed for other purposes than those of agriculture. These horses are, for the most part, of a chesnut colour, though sometimes sorrel, which uniformity shows that they have been kept tolerably pure. They are distinguished by roundness of barrel and compactness of form generally, combined with great activity. They are exceedingly stanch to the collar, free from any redundancy of hair on the legs, and are by no means coarse about the head. They are rarely of a large size, but usually range from 15 to 15½ hands. The most inferior kinds have ragged hips and *goose-rumps.* It speaks highly in favour of this breed that, at the late meeting of the Royal Agricultural Society of England at Northampton, they carried away two prizes, besides one high commendation; indeed the best and the second best 2 year-olds were of the Suffolk breed as well as the second best horse of any age. As these horses are inclined to be small, size should be attended to and encouraged as much as possible. It should also be observed that this breed of horses are rather more liable to strains of the sinews and ligaments than others.

The *Clydesdale* horses are larger than those just mentioned, and are found most extensively in the neighbourhood of the river after which they are called, where their services in the one-horse carts of the district are well appreciated. Indeed there is no description of animal that appears better adapted for single-horse carts, or that can get through more work in the course of the day. They are for the most part powerful horses, standing about 16 hands high, and are extremely active and indeed very fast walkers. Their faults are a tendency to light bodies and long legs, and some of them are hot workers: when free from these defects they are certainly a most valuable kind of animal for agricultural purposes. They are generally docked in their native district, and their short tails, so unusual in cart-horses, give them a very unique appearance. A pair of Clydesdale horses will plough a larger breadth of land than almost any other kind of horses, but they require to be well fed in a greater degree than most others. They have usually rather small heads, which, with their great activity, shows that their pedigree is not altogether

of the cart kind. We are told that an Earl of Huntingdon imported some Dutch mares (a breed then much thought of) into the district of the Clyde, which being crossed with the native breed (probably the ancient pack-horse), thus became the founders of the now highly appreciated Clydesdale. The prevailing colour is black, but there are also many browns and some greys. The great bulk of this breed is susceptible of much improvement by careful selection in breeding, and avoiding the evils which I have pointed out as those to which the breed are prone.

The *Cleveland* cannot certainly be considered as a breed of cart-horses, though they are occasionally employed for this purpose. There was a very fine specimen of this breed exhibited at Northampton as a stallion for getting cart-horses, and which animal was highly commended; but although unquestionably he was calculated, if put to suitable mares, to beget some excellent progeny for carting purposes, yet it must be acknowledged that he was still more valuable in his more legitimate sphere as the sire of carriage-horses. I understand that, as a matter partly of curiosity and partly to decide a difference of opinion, the measurement of this horse was taken at the girthing-place, and the result was that, though equal in height, he proved 1 foot less in circumference than many of the other horses. I am glad, however, to find that at the forthcoming meeting at York, numerous prizes will be awarded to various kinds of horses, so that the merits of the Cleveland Bay will be tested as well as others of the lighter breeds.

These are the principal breeds of cart-horses found in this country; but there are very many useful animals to be met with in various districts though belonging to no distinct breed, and there are unfortunately too many of a very different class whose only pretensions to the name of "cart-horse" consists in their great deficiency of breeding and their want of adaptation for any other purpose. These undersized badly formed horses usurp the place of better animals, and their perpetuation is therefore to be deprecated.

There is a certain average size for horses best suited to agricultural purposes, that is, they should be strong enough to render more than two horses in a plough a needless expense, and yet not so heavy as to impair their speed and activity. From 15 to 16 hands appears to be the proper height; lower than the former, or higher than the latter, is equally objectionable.

### 2. *Breeding and rearing.*

There is no branch of a farmer's business to which so little attention is generally paid as that of breeding. It is

often regarded as a matter of chance whether the produce will turn out valuable or worthless; whilst, on the other hand, there is nothing so true as that unhealthy parents will not produce healthy offspring. It is very possible that where one parent is sound and the other diseased the progeny may turn after the former; but then it is just as likely to turn after the latter, and therefore it is very unwise to risk the expenses of breeding on such an uncertainty.

There are few subjects connected with breeding more interesting than the relative influence of the male and female parent, and few on which such different opinions prevail. Whilst some ascribe the principal influence to the male, others consider that it is chiefly due to the female, and there are not wanting illustrations that appear to support either theory. The freaks of nature (as they appear to us) are certainly very curious, and people are often more struck by a remarkable exception than even by the rule, and are disposed to found their theories accordingly. The Arabs of the desert, so celebrated for their scrupulous attention to the purity of their breed of horses, are comparatively indifferent as to the stallion, but prize and preserve their mares with the most rigorous care. They will part with the former for an equivalent remuneration, but scarcely anything will induce them to dispose of their mares if they belong to the true breed. From this well-known fact it has been naturally inferred that they consider the influence of the female as pre-eminent, and the supporters of this theory adduce the fact just mentioned as a strong argument in its favour. Indeed, at first sight it would appear, when we consider the more intimate connexion of the female with the offspring, kept up during the long space which elapses between conception and birth, that the influence of the dam must be greater than the sire.

Facts, however, appear rather to support an opposite doctrine. The offspring of the male ass and the female horse resembles the former far more than the latter: the long ears, spare muscular development, narrow feet and sluggish action, are almost equal peculiarities of the mule and the ass, and strongly attest the plebeian origin of the former. The size, too, approximates to the ass, for the large Spanish mules we sometimes meet with are begotten by asses of great size.

It is surprising, too, what large colts small mares will breed when begotten by horses of great size. Pony mares will thus rear stout cobs and galloways; and well-bred mares about 15 hands high will throw good sized carriage-horses if put to a powerful stallion.

We may, therefore, from these and other similar facts which could readily be adduced, be justified in concluding that so far

as regards the size, general appearance, external form, and muscular development, the influence of the male is superior to that of the female. But, although in obedience to this principle I believe that it is principally by means of the male that various improved breeds will be rendered more perfect, yet I by no means wish it to be inferred that I consider the qualities of the female a matter of indifference. So far from this being the case, I would censure in the strongest terms that utter neglect of the qualifications of the female which is so frequently displayed—particularly with horses—regarding it as the most grievous error appertaining to breeding. It is of equal importance to study the qualification of the female as of the male, though their respective excellences may not be the same. Hereditary disease and weakness of constitution are much more likely to be communicated to the offspring by the mother than by the father, which is in keeping with the fact of the long and intimate connexion kept up between the dam and the offspring, both before and after birth, till weaning takes place. As the same blood nourishes both, both are likely to become affected by any unhealthy change in this fluid. Soundness of constitution is therefore an indispensable requisite in the female.

I offer these remarks as general rules, but by no means as rules without exceptions; and I do not wish it to be inferred that the female has no influence in those qualifications in which the male is pre-eminent, for it sometimes happens that the female has greater influence in these respects than the male, and in all cases some degree is possessed. Thus, when a handsome well-bred mare is covered by a large coarse stallion, the defects of the latter are generally considerably softened down—the head is finer, and the frame of the offspring, though larger than that of the dam, is handsomer than that of the sire. The result of this cross is generally superior to an opposite assortment, where the sire is thorough bred and the dam a coarse heavy animal. The progeny in this case is often unequal and ill arranged, possessing perhaps the fine legs of the sire and the coarse body of the dam. We may, therefore, with much propriety endeavour to modify the defects of one parent by opposite qualities in the other; and though we may not always, we shall often, succeed to a certain extent in the accomplishment of our wishes. We shall succeed, however, the more perfectly by attending to those qualities in which the respective influence of the male and the female is most likely to be exercised: that is, the size and external conformation we should seek to govern by means of the male, and the constitution and nervous system through that of the female. The fact, however, of the male animal begetting from 50 to 100 offspring in the course of a year, whilst the female does not

produce more than one or two, must and always will cause improvements to be effected in breeds of animals principally by means of the male.

The breeding of farm-horses resolves itself into two branches: the principles of breeding and the practice. Unless the former are correct the latter will be continually at fault, and it will be a matter of chance and uncertainty whether success or failure is the consequence. "Like begets like" is an axiom that cannot be disputed, and it is vain to expect valuable progeny unless the parents possess the qualifications which we seek to obtain in the offspring. The principal object in breeding cart-horses—as in other animals—is gain. The breeder is desirous of breeding animals that will yield him the largest pecuniary return; consequently the most profitable animal to rear is that which is likely to suit the London market, and so realize the high prices which the wealthy brewers are willing (or rather are obliged) to give.

It is necessary, however, in addition to the possession of suitable mares and horses, that the pasturage should be also abundant and nutritious, otherwise the progeny will become monsters in ugliness rather than in size. Where, however, the land is suitable, as in Leicestershire and other midland counties, the breeding of these massive animals is more profitable than that of other agricultural horses.

The practice adopted is to select the best mares on the farm for the purpose of breeding; sometimes nearly the whole horse stock on the farm consists of breeding mares and two and three-year old colts and fillies. Of course, in such instances it is necessary to keep rather a large working stock for the size of the farm, in order that the mares may be spared for two months in the spring without inconvenience. The breeder may or may not possess a stallion himself; if not, there will be little difficulty in finding a suitable one, as in consequence of the male serving so many females, it is of course more difficult to find a number of suitable mares than it is to find a single horse with the proper qualifications. Where the purpose is so specific as in the style of horse I am now speaking of, it is needless to describe the sort of animal we should choose for a stallion. The breeder will not select the horse unless he is large and powerful, and yet compact, standing perhaps nearly 17 hands high, and yet comparatively short in the legs, so as to deceive a bystander with regard to his height; there is no point more desirable than that the horse should appear smaller than he really is; it is at once a sure proof that the animal is symmetrically formed. However, we may take it for granted that the stallion is a fine handsome animal. Any observations will be more useful which point out those defects that may co-exist with this fine appearance. First, then, we

may notice that to which this breed is so very much predisposed —the possession of large ring-bones and side-bones on the pasterns. Perhaps it may scarcely be possible to find a suitable horse entirely free from this defect; but we should at any rate select one that is most free, and reject altogether a horse that is lame from such causes.

The hock is a most important joint, being severely called upon in heavy draught, and consequently liable to strains. The existence of any disease of this joint, whether curbs, spavins, or thoroughpins, should therefore be sufficient to condemn the horse. The hocks should be broad in front, and neither too straight nor too crooked, nor yet cat-hammed. When we consider that a heavy dray-horse, working in the shafts, has perhaps a load of four or five tons behind him, which, in going round a corner, devolves on him alone, and in the action of walking must thus be thrown alternately on each hock, the importance of having this joint free from disease and from all tendency to disease must be very apparent.

Next in importance are the eyes, which in the old horse should be free from every semblance of defect (unless through accident), and in the young horse should also be free not only from actual disease, but from all appearance of tendency to it. The eyes should be full without being too convex; for the small sunken eye is certainly much more liable to disease than the large clear eye. The fore-legs of the horse should be strong, and flat below the knee, and by no means round and gummy, either before or behind; for cart-horses having always a stronger predisposition to swellings and humours than other horses, it is most essential to guard against this evil by selecting the stallion as free as possible from such predisposition; and, for the same reason, the less white hair there is about the legs the better, and indeed there should not be too much hair of any colour. The fore-arm should be strong and muscular, and should not stand too much under the body, for although this is not of the same importance as with other horses, yet it is extremely desirable. So likewise with regard to the shoulders: they should be tolerably oblique, for when the shoulders are good, the horse is likely to be a good walker; the elbows should not be too close to the chest, but there should be plenty of room to put the hand between them. This pinning of the elbow to the ribs was a principal fault in one of the finest horses exhibited at Northampton, and it caused the animal to have very bad action. With regard to the neck, it had better be rather too thick than too thin, of average length, and, if moderately arched, so much the better. It is a great fault in all horses—but particularly in cart-horses—to have a ewe neck. The angles formed by the junction of the neck with the body,

and by the head with the neck, should not be too acute, for such horses are very liable to poll evil, from the disposition induced of throwing up their heads suddenly, and thus striking their poll violently against some object above them, such as a low doorway. Suffolk horses have a slight tendency to this fault. With regard to the other points, the back should be straight and broad, the ribs well arched, and the false ribs of due length, so as to give the abdomen capacity and roundness; the tail should be well set out, not too drooping, and the quarters should be full and muscular. The horse should girth well, and, if a large horse, should be 8 feet in circumference.

The foot is a matter of very much importance: the tendency of many heavy horses is to have thin flat feet, but a stallion so constructed is exceedingly objectionable. An abundance of horn, so as to afford a firm holding for the large nails and heavy shoes which such animals are obliged to wear, is extremely desirable, and the feet had better be too large than too small.

With regard to the mare, she should possess as many of the points I have enumerated as possible.

Having thus ascertained that the stallion is free from the cardinal faults which I have pointed out, and rich in the virtues I have enumerated, we should also be satisfied before securing his services that he is well suited as regards size, strength, breeding, and activity for the mare we wish to put him to. If the mare is small but symmetrical (for we cannot suppose any sensible breeder will breed from a little ugly mare), we may very properly select a large sized stallion, taking care, however, that he is an active mover; such a horse indeed as gained the first prize at Northampton. If, on the other hand, the mare is large, and has a tendency to coarseness, we should select a middle-size horse of symmetrical appearance,—a Suffolk-Punch for example; and such a one as either of the prize animals at Northampton belonging to this breed.

Where the object is specific, viz., to lighten and render more active a coarse and slow breed of horses, we may then have recourse to the Cleveland with great advantage, taking care, however, that the subject of choice, in addition to symmetry and activity, should be as deep in the ribs and short in the back and the legs as the Cleveland bay can possibly be. Beyond the Cleveland, however, we must not go; I deprecate in the strongest terms that utter departure from the principles of nature which is sometimes displayed in the production of a nondescript animal—the cross between the thorough-bred horse and the cart-mare—an animal often possessing the body of one parent and the legs of the other—the vices of both, with the virtues of neither.

One precaution in breeding I would strongly recommend,

which is never knowingly to breed from animals of vicious dispositions. It is unfortunate enough for society that the vicious amongst mankind are enabled to perpetuate themselves: it were folly indeed in the highest degree to permit the vices of quadrupeds to be added systematically to the catalogue of crimes. Biters, kickers, gibbers, and horses difficult to shoe, should be therefore carefully eschewed; and so likewise should the possessors of the minor vices and other hereditary faults, such as crib-biters, roarers, hot-workers, &c.

Although the breeding of cart-horses more frequently forms a part of the farmer's business than that of any other description of horse, it has not yet received that attention that its importance merits, or that in my opinion the necessities of agriculture will for the future obtain for it. Too frequently have the infirmities of the mare caused her to be selected for breeding, and too often has the size of the stallion been his only recommendation. It would be well if, instead of this, the following rule were observed, viz., *never to breed from an old infirm animal*, but to select for the purpose *the youngest and best mares on the farm*. There is not even the excuse amongst farm-horses which exists amongst others for breeding from inferior mares, as the cart-brood mare will not require more than two months' rest, and that during a leisurable period of the year, thus being otherwise adequate to most of the ordinary requirements of the farm.

The object, however, to be kept in view ought to be to endeavour to breed the most valuable description of animal, and one that will afford the highest pecuniary return. Due regard must of course be paid to the nature and quality of the land; for instance, it is vain to attempt, on ordinary or inferior land, to rear those leviathans which command such high prices from the London brewers.

There is, however, a smaller description of horse that can be bred to advantage, being more suitable for agricultural purposes, and yet large enough to command a good price in the London market. Such an animal, averaging about 16 hands, short in the back, and round in the barrel, with well-proportioned limbs, is sure to command a good price, and to pay well for breeding. Such horses, however, can only be bred by devoting the best mares to the purpose, and keeping the colt well through the two first winters, so that his growth shall not be stunted and his symmetry destroyed. The breeding of farm-horses can be entered into with far less inconvenience than that of any other description, inasmuch as there is far less necessity for taking the mare from her usual work for some time previous to foaling. A half-bred mare is incapable of pursuing very fast work for many months before foaling, whilst a cart-mare can continue her usual

labour till within a very few weeks of this period. This being the case, there can be no valid reason why the best and healthiest mares on a farm should not be used for breeding. It is merely necessary to keep them in good fair condition, and not to put them to severe strains, and then the loss of work will not be more than a few weeks previous to foaling, and about double or treble this period afterwards. The farmer may depend upon it, that if he has suitable pastures for rearing the colts, and selects the best and finest mares he can obtain, and puts them to the most desirable stallion, the breeding of no description of animal will pay him better than cart-colts. They can be reared with less risk, and will produce a quicker return than any other kind of horse; while they do not involve the expense and risk in breaking, by which so many valuable half-bred horses are ruined, through the ignorance, recklessness, or bad temper of the breaker. One fact, however, should be borne in mind, which is that if a full return is anticipated, the young animal should be kept tolerably well through the winter months: for if, as is too frequently the case, it be *half starved*, the loss from deficiency of *symmetry, size, and strength*, will be much more than can be compensated by any *saving* of food.

In rearing young colts much care should be taken; they should be handled very early and get used to the halter, by which means, in case of any accident, not half the risk will be incurred in the treatment as when the colt is allowed to remain wild and ungovernable. At Michaelmas the colt is usually weaned, soon after which he should be allowed to taste a few oats which will promote his health, strength, and condition, and conduce very much to his symmetry. A peck of oats a-week may be enough at first, and through the greater part of the first winter, increasing it gradually to a peck and a half. During the second winter, two to three pecks per week may be given, and at two and a half years old the colt may be broken to harness, doing perhaps half a horse's work, and then his corn is to be increased accordingly. Carrots form an excellent addition to the food of colts, particularly through the first winter.

### 3. *Keeping, whether in the Stable or in the open Air.*

During eight months in the year, viz., from October to June, there can scarcely be a doubt that it is far more desirable in every respect to keep working-horses in the stable.

The effect of exposure to *cold* and *wet* throughout this period of the year is indeed tantamount to *the waste of so many quarters of oats;* for, if the animal heat is permitted to be thus purloined by means of exposure, an additional quantity of fuel in the form of food is necessary to supply this deprivation, for there is

no fact in animal chemistry better established than this, that the principal use of the non-nitrogenized or carbonaceous part of food, is to furnish a supply of carbon, which, uniting with the oxygen of the atmosphere in the lungs, gives out heat, as in ordinary combustion, and thus serves to keep the animal temperature above that of surrounding objects. It is therefore a very *costly* method of procuring a certain amount of animal heat, when such heat or a good portion of it can be retained by keeping an animal in a *comfortable* stable. Besides which, the effect of turning a horse into the open air is to cause him to have a long thick coat, this being one of Nature's rèsources to counteract the effect of cold. When a horse is worked with such an external covering, he sweats readily and profusely in consequence, and is faint and weak after very little exertion. Thus in whatever way we look at the question, whether theoretically or practically, "turning out" is decidedly objectionable in every respect. With regard, however, to the turning of our horses out during the three or four warmest months of the year, many of the foregoing objections do not apply. For my own part I have been in the habit, after the warm weather has thoroughly set in, and the hay has been made and carried from the pastures, to turn out my cart-horses during the night, and I have never seen other than benefit arising from the practice.

Its advantages are, that much litter has been thereby saved, as well as considerable labour in carting green food or hay to the stable. The coolness of the pastures during the night as compared to the heated stables is very conducive to health; and, indeed, I have generally found that the horses have gained flesh during this period.

One of the principal objections to this practice is, that the dung is likely to be dissipated, and lost. This, however, may readily be avoided by employing a lad with a wheelbarrow and shovel, to collect the droppings from time to time into a heap, to be afterwards mixed with ashes or earth, to be laid out in the pasture at a more suitable period of the year. This mode should also be followed with regard to the dung of cattle; the expense is trivial, and is far more than compensated by the advantages that attend the saving of the herbage from the too powerful action of the dung, and its more economical use when collected together.

Another objection to the practice is, that horses are more likely to get kicked or otherwise injured by being thus turned out. This certainly is of some weight, and is only to be obviated in a measure by abstaining from turning out those horses that are at all viciously disposed.

The practice of turning out during the nights of summer

applies only to those farms where there are abundant pastures, and consequently where the after-grass abounds.

In farms where pastures are deficient, the horse may be turned into yards, and supplied with green food to equal advantage. When the nights get cold, and before the moulting season, the horses should no longer be turned out at night, but the change may be rendered gradual by letting them out a couple of hours in the afternoon after the day's work is over, and also on Sundays during the day, if the weather is fine.

So far, and so far only, I believe, the practice of turning out working horses is consistent with reason.

### 4. *Feeding in different Seasons.*

We now approach the most important part of our subject, viz., "feeding in different seasons;" for the expense of keeping the horse-power on a farm is very great, and forms a very considerable proportion of the annual expense of the farm, so much so, indeed, that it is worthy of the utmost consideration whether some saving cannot be effected in this large item of expenditure. It should be borne in mind, however, that there are two methods of effecting or endeavouring to effect this saving: one the lessening the quantity or quality of the food, the other the *retaining the quantity of food,* but *reducing the number of horses.* Now I must freely confess that I incline towards the latter method of lessening these expenses, and I do not sympathize with the advocates of the starvation principle. Many writers in magazines and other works have laboured very ingeniously to show how very *cheaply* horses can be kept; one contends that a liberal supply of carrots* is alone sufficient without any other food, another that abundance of straw and a mere taste of corn is enough; after the precedent, no doubt, of those retailers of food who in the dark alleys of the metropolis vociferously proclaim their "ha-porth of peas, and a suck at the bacon for nothing," or the still more scientific discoverer who found a mode of keeping his horse upon sawdust, though, unfortunately, the animal died just as his plan was reaching perfection.

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* Although according in the writer's objection to the "starvation system," and being quite satisfied from long experience that *good work* can only be obtained by *good feeding*, yet I cannot avoid mentioning that, when residing during the last year at Boulogne, I frequently visited the farm of a Norfolk gentleman, who there held a couple of hundred acres of turnip-land, cultivated as cleanly as if it were in England, and that he fed his cart-horses, during the entire winter, solely on carrots, chaff of clover, and straw; without any portion of oats or beans. The cattle were of the ordinary Norman breed—something like the Suffolk-Punch—ploughing, in pairs, full an acre a day from the stubble, and were in excellent working-condition.—F. BURKE.

I have before observed that the number of horses kept on a farm must be regulated by the requirements of the seed seasons. If eight or ten horses are enough at these periods, they are surely enough for the other portions of the year; it is, of course, an object to take every advantage of fine weather to make both men and horses move nimbly, working at this period of the year both early and late. To accomplish these desirable purposes it is essential that the men should be *well paid* and the horses *well fed;* an extra allowance in the wages of the former for his over-time will be money exceedingly well laid out, and not only is it essential that the horses should have an additional allowance of corn during this period, but their *condition* should be such that they be capable of undergoing extra exertion without injury or fatigue. If they are half-starved throughout the winter they can hardly be expected to bustle through the barley and turnip sowing as they ought; and if grass is their only diet through the summer, how can they be expected to perform their work freely through the autumnal wheat sowing?

Another advantage arising from keeping horses in good condition is, that *two* horses *well* fed will do the labour of *three* horses *badly* kept, so that two in a plough will be sufficient during the busy seasons. At a period like the present, when British agriculture has so many difficulties to encounter and a foreign competition to meet, it is of the utmost importance to ascertain and to adopt the most economical practices; but not to be drawn into error by misplaced or *false* economy, nor to be wedded to customs whose antiquity is their only merit. If we seek for illustrations in the human subject for the desirableness of liberal feeding we have not far to go for abundant illustrations. What class of men can do more work in a given time, or do it more economically, than the navigators on our railways, and no class of men live on more nutritious food? The analogy obtains likewise amongst railway horses with equal force. A few months since the writer was travelling on a newly opened railway in the same carriage with one of the contractors that had been engaged in its completion. He was one of the order of sub-contractors, whose profits can only be obtained by adopting every mechanical contrivance calculated to save labour, and, in fact, by getting both manual and horse labour effected at as low a rate as possible. I entered into conversation with my companion by remarking that he must have felt severely the high price of oats and beans which ruled throughout the first six months of 1847, and I asked him if he reduced the allowance of corn for his horses in consequence; he replied that he had been sorely punished by this extravagant price, which was one-third higher than it was when he took his contract, but notwithstanding this he gave the same amount of food to his

horses, which indeed was almost unlimited, averaging *three bushels of oats and half a bushel of beans* each horse per week, and the best hay *ad libitum.* I asked him if he was quite sure that he could not reduce the amount of corn with advantage, even if he worked the horses more moderately in consequence: he rejoined that he had tried this plan, though not latterly, and was convinced that the system he adopted was the cheapest in the end; his horses worked hard, and for twelve hours in a summer's day, and it was only by having as much corn as they chose to eat that they could do this. Now this is important evidence in favour of liberal feeding, for it is not the practice of one individual only but of hundreds, who are obliged to study economy to the utmost in their arrangements. How strong is the contrast between the strength of such horses and that of many farmers whose teams of four horses in a plough are often to be seen on ordinary or even on light land, moving at the rate of two miles an hour through a day of eight hours' duration. In the keep of these horses grass in the summer and straw in the winter form the bulk of their food, assisted, perhaps, by a bushel or two of oats per week during half the year. In consequence of this low feeding their stamina is low, they are always under *par*, and are incapable of doing a hard day's work. Though their bellies are large and distended their ribs are plainly to be seen, and their actual weight from deficiency of muscle is not more than two-thirds what it ought to be. Now I do not mean to assert that farmers' horses ought to be fed so high as railroad horses; their work is different, and they are kept under different circumstances; their food should therefore be regulated accordingly, avoiding alike the two extremes of too high and too low feeding. The circumstances in which they differ from contractors' horses are these:—they are required to be kept all the year round, their work varying according to the season; their provender being raised on the farm and not purchased must depend very much upon the season, being also often very indifferent as regards its quality, whilst at the same time being unsaleable, the damaged provender must be consumed at home; then, again, the litter which the contractor is obliged to purchase costs the farmer nothing, being compensated for by the dung.

There is not, therefore, the same necessity for getting out of each horse the utmost amount of work, but he may well be expected to observe the *juste milieu,* keeping his horses in such condition throughout the year as will enable him without injury to exact some extra labour during the busy periods.

Taking it for granted that this is desirable, I proceed to consider the description of food, with its quantity and quality, necessary for this purpose; and here I must observe that food must certainly be regulated by the description of farm, for in

some instances pasture or water meadow hay is very abundant, and in other cases very scarce. In some the amount of straw is enormous, in other cases by no means considerable, being no more than sufficient for the cows or young stock. However much the quantity and quality of hay and straw may vary, it may be asked have we any substitute that will supply the place of oats? To this I unhesitatingly answer, No! In this country, if a horse is to be kept in working condition, he must have a certain amount of concentrated food, and no form is more suitable for the stomach or more conducive to health than that of oats. To establish this position, let us consider for a few minutes the construction as well as the functions of the stomach of the horse as compared with the ox, an animal that is capable of subsisting readily on a large amount of unnutritious food.

The stomach of the horse is comparatively small, holding about three gallons, whilst the ox possesses no less than four stomachs, the *first* of which is considerably *larger* than that of the horse. This difference shows, what indeed the habits of these animals also demonstrate, that whilst the ox is so constructed as to consume a *large* quantity of food *at a meal*, the horse, on the other, is adapted to consume a *moderate* quantity, and *often*. If such a mass of food as is often found in the maw of the ox were contained in the stomach of the horse, it would be impossible for this animal to perform those exertions he is often called upon to accomplish, for the loaded stomach presses against the midriff or diaphragm, the muscle of respiration, and would thus materially retard or prevent its action. The internal surface of the stomach of the horse is worthy of particular notice. One half, or that nearest the cardiac orifice, as the entry to the stomach is termed, is lined by a white coat called the cuticular, from its being comparatively insensible like the cuticle or outer skin, and the other half has a reddish coloured coat called the villous, which is not only sensible but secretes the gastric juice, by which the food is converted into *chyme.* This chymification, as the first act of digestion is termed, is thus accomplished by means of the acid of the gastric juice; and *small* as the stomach is, yet only *one-half* is really devoted to the process of digestion, the other moiety acting as a reservoir for the food. Now it is a well-known fact, that in proportion to the exertions of an animal is the expenditure of the muscular system, and the consequent necessity for an equivalent supply of nutriment.

If, therefore, bearing this in mind, we consider the smallness of the stomach of the horse, it seems evident that he was intended by nature to consume concentrated food such as grain, and the formation of the molar teeth strongly corroborates this view of the matter. These molar teeth, or grinders, as they are commonly and very expressively termed, are broader and less cutting

than those of the ox, but decidedly better adapted for grinding corn, as in a mill, for the teeth of the upper and lower jaws do not exactly correspond, but the teeth of the latter are narrower as well as the jaw itself, so that the lower jaw is moved from side to side, and the grain is thus triturated and ground, as between two mill-stones.

With this information on the structure of the masticatory and digestive apparatus of the horse, it is impossible to arrive at the conclusion that such poor and bulky food as straw or roots is a wholesome and nutritious diet for working-horses. It is, indeed, as unwholesome and unnutritious *as it is for man to live entirely on potatoes.* With such food neither the quadruped nor the biped is capable of doing a fair day's work without great exhaustion.

Food, it is well known, consists of two kinds, one carboniferous and devoid of nitrogen, whose use it is to keep up the animal warmth; the other kind possessing nitrogen, and thus supplying the muscular system with the requisite nourishment. The usual forms of the latter are albumen and gluten; those of the former starch and sugar. It is essential, therefore, that the food of the horse should contain both these classes of elements; unless the nitrogenized elements are supplied, the expenditure of muscular vigour cannot be replaced, and unless the carboniferous portion is furnished there will not be sufficient fuel to keep up the animal temperature. We must, therefore, endeavour to ascertain how far the various articles of horse provender supply the essential ingredients required by the system.

According to Professor Johnston and other of our best authorities on the subject, the following table will represent the nutritive qualities of the various articles used for horse food:—

| | Water. | Husk, or Woody Fibre. | Starch, Gum, and Sugar. | Gluten, Albumen, &c. | Fatty Matter. | Saline Matter. |
|---|---|---|---|---|---|---|
| Oats | 16 | 20 | 45 | 11 | 6 | 2·5 |
| Beans | 14 | 8 to 11 | 40 | 26 | 2·5 | 3 |
| Peas | 14 | 9 | 50 | 24 | 2·1 | 3 |
| Indian corn | 14 | 6 | 70 | 12 | 5 to 9 | 1·5 |
| Barley | 15 | 14 | 52 | 13·5 | 2 to 3 | 3 |
| Meadow hay | 14 | 30 | 40 | 7·1 | 2 to 5 | 5 to 10 |
| Clover hay | 14 | 25 | 40 | 9·3 | 3 to 5 | 9 |
| Pea straw | 10 to 15 | 25 | 45 | 12·3 | 1·5 | 4 to 6 |
| Oat straw | 12 | 45 | 35 | 1·3 | 0·8 | 6 |
| Barley straw | 12 to 15 | 50 | 30 | 1·3 | .. | 5 |
| Carrots | 85 | 3 | 10 | 1·5 | 0·4 | 1½ to 2 |
| Swedes | 80 | 3 | 14 | 2 | ·3 | 5 |
| Linseed | 9·2 | 8 to 9 | 35·3 | 20·3 | 20· | 6·3 |
| Bran | 13·1 | 53·6 | 2 | 19·3 | 4·7 | 7·3 |

From this table it will be perceived that the nutritious part of food consists of three portions, the nitrogenized or flesh-making elements—the fat—and the gum, sugar, and starch. In estimating the relative value of horse food, I propose to consider separately the value of each of these kinds, and in so doing to take clover-hay for our standard of comparison :—

| | | | |
|---|---|---|---|
| Clover-hay then contains | of | starch, gum, and sugar, | 40 lbs. |
| ,, | ,, | fat . . . . | 4 ,, |
| ,, | ,, | albumen, &c. . . | 9 ,, |
| | | Making of nutritious elements 53 parts in | 100 |

If we value these 53 lbs. of nutriment at 1*d.* each, we still find that it will bring the value of the hay to 4*s.* 5*d.* per 100 lbs., or about 5*l.* per ton, which is pretty nearly the truth for the best hay. It does not, however, seem fair that the starch, &c. should be valued so high as albumen, as, if we seek for a larger proportion of the latter in any food, we are obliged to pay a higher price for it. I shall therefore assume that the value of albumen, &c. is 50 per cent. higher than that of starch, and as fat is also a somewhat rare and costly product and of much value in food, I shall place that at the same rate as albumen, so that, estimating it in this way, we bring the value of the hay to 5*l.* 12*s.* 6*d.* per ton; or, if this is thought too high, we can reduce the value of the starch one-eighth, which will bring back the price of the hay to about 5*l.* per ton. It will be fairer, however, to take 5*l.* 12*s.* 6*d.* per ton as the value of such hay, for I am inclined to think that the nutritive contents of hay, as compared with other food, have been somewhat overrated. It must be borne in mind that the amount of nourishment *extracted* from hay varies extremely with the digestive powers of the horse, for whilst some with great digestive powers will extract the greater part of the nutriment, in others with weaker capabilities not more than *one-half* will be assimilated. All herbivorous animals, however, require a tolerable amount of bulk in their food so as to *distend* the stomach and bowels to a certain degree by which the digestive processes are properly carried on, so that whilst a horse can, not only exist but perform a moderate amount of work with hay only, he could not do so if kept entirely on oats and beans. If a horse is required to be kept in idleness it is no doubt cheaper to feed him on hay alone, for he will be able to eat a sufficient quantity, so as to extract from it the requisite amount of nutriment. When, however, he is called upon to work he requires at least double or treble the proportion of the muscle-making elements of food; to obtain which, if hay were his only diet, he would require far more than the power of his digestive organs would dispose of, besides which such a mass of food would produce such mechanical pressure on the chest as to obstruct respiration, and would also demand a much greater

amount of nervous energy to be devoted to the functions of digestion than he would be able to supply; for the less concentrated the food the greater the demand on the digestive functions. When labour, therefore, is required, we must have recourse to more concentrated food, though we shall have to purchase it at a dearer rate. The food principally used for this purpose in this country, and which appears to agree best with the constitution of the horse, is oats.

If we refer to the analysis of oats we find that in 100 parts there are contained of—

| | |
|---|---|
| Starch, &c. . . | 46 lbs. |
| Fat . . . | 5 ,, |
| Albumen, &c. . . | 11 ,, |

We may consider the value of oats to be about 3*s*. per bushel weighing 37 lbs., or 3*s*. 4*d*. per bushel if of 40 lbs. weight, which will bring the cost of 100 lbs. to nearly 8*s*.; now if we value the constituents at the same ratio as in hay, we find—

| | | | *s.* | *d.* |
|---|---|---|---|---|
| Starch, &c. | 46 lbs. at 1*d*. per lb. . . | | 3 | 10 |
| Fat . . . . | 5 ,, | 16 lbs. at 1½*d*. per lb. | 2 | 0 |
| Albumen, &c. | 11 ,, | | | |
| | | | 5 | 10 |
| Which sum will be insufficient; if however we add one-third . . . . . | | | 1 | 11 |
| We have . . . . . . . | | | 7 | 9 |

Or nearly sufficient; so that it appears that the nutriment contained in oats is one-third dearer than that in hay; to compensate for which extra expense the food is more concentrated, easier of digestion, and its nutritious properties consequently likely to be *more perfectly extracted*.

Again, with regard to beans, we find that 100 parts contain of

| | | | *s.* | *d.* |
|---|---|---|---|---|
| Starch, &c. | 40 lbs., which at 1*d*. will amount to | | 3 | 4 |
| Fat, &c. | 2½ ,, | 28½ lbs. at 1½*d*. do.. . | 3 | 6¾ |
| Albumen, &c. | 26 ,, | | | |
| Together amounting to . . . . . . | | | 6 | 11¾ |
| It will therefore be necessary to add one-fourth . | | | 1 | 8¾ |
| Which makes . . . . . . . | | | 8 | 8½ |
| For we find that 1 bushel of beans, weighing 64 lbs., is worth, on the average at 44*s*. per qr. | | | 5 | 6 |
| Half a bushel more, or 32 lbs. . . . | | | 2 | 9 |
| The odd 4 lbs. . . . . . . . | | | 0 | 4 |
| Making altogether . . . . . | | | 8 | 7 |

for 100 lbs. of beans; so that it appears that though the nutriment contained in beans is one-fourth more than that contained in hay, yet when the flesh-making constituents are required it is a somewhat cheaper source than oats, and still more concentrated. If, however, beans are given very freely they have a very heating or stimulating effect; the blood abounds too much with fibrine, and inflammatory swellings of the limbs and the absorbent vessels occur, so that beans require to be given with moderation and caution, and are principally of service when horses are severely worked, in which case they are given with advantage in combination with oats, and in the proportion of one-third or one-half the weight in beans. When oats are very dear and beans are moderate in price there is, of course, a disposition to substitute the one for the other, and it is thought that if combined with bran their injurious effects may be obviated. This, however, is the case only to a certain extent: beans are very astringent in their nature, whilst bran, from its mechanical effects, is relaxing, and so far these substances supply each other's deficiencies: also with regard to fat, with which bran abounds and beans are deficient. In other respects beans and bran closely resemble each other, both abounding with albuminous elements, whilst beans as compared with oats are deficient in starch, &c., and in bran scarcely any exists, so that these two substances are not capable of supplying each other's deficiencies. The writer experienced this fact during the last year, when in consequence of the excessive price of oats he endeavoured to substitute a bushel of beans and a bushel of bran for 2 bushels of oats, but it was soon found that the horses did not do so well on this diet.

With regard to the use of roots as food for horses, there is only one that can with any advantage be employed, viz., carrots, for we find that horses altogether refuse mangold-wurzel and common turnips, and will eat only a very moderate quantity of swedes. I am inclined to think, however, that the merits of carrots have been greatly overrated when they have been sold at such prices as 40*s*. to 50*s*. per ton for the purpose of feeding horses. Let us endeavour to see, however, whether carrots are adapted to supply the place of oats and beans. We may, I think, consider that an average-sized cart-horse will require daily, when moderately worked, between 16 and 17 lbs. of the best hay,—

| | Starch, &c. | Fat. | Albumen, &c. |
|---|---|---|---|
| Best hay, between 16 and 17 lbs., containing | 6·66 | ·66 | 1·5 |
| Oats 10 lbs. . . . . . . | 4· 6 | · 5 | 1·1 |
| Making together . . . . . | 11·26 | 1·16 | 2·6 |

So that to obtain each of these ingredients respectively, it would be necessary for the horse to eat daily—

| | |
|---|---|
| Carrots to supply albumen . . . | 174 lbs. |
| Ditto the fat . . . . . | 300 „ |
| Ditto the starch, &c. . . . . | 111 „ |
| | 3)585 „ |
| Or taking the average of the whole . | 195 „ |

A quantity much too great for the stomach of the horse, and injurious likewise from containing no less than *eighteen gallons of water.*

Horses have certainly been kept principally on carrots and straw, but their work has generally been slight and on light sandy land, where perhaps two-thirds of the horse power in good condition would have done equally well.

Carrots, however, when grown on a farm can be advantageously used in combination with other food, if given in such proportion that the quantity of water contained in them shall not prove injurious, and the three principal constituents shall be combined in the proportion we have previously stated, as constituting healthy feeding with oats and hay. A working-horse requires, as we have seen—

| | *d.* |
|---|---|
| Oats 10 lbs., costing . . . | 9·6 |
| Clover hay 16½ lbs., costing . . | 8·6 |
| Amounting together per diem . . | 18·2 |

Or 10*s.* 7½*d.* per week; which supplies, as we have seen—

| Starch, &c. | Fat. | Albumen. |
|---|---|---|
| 11·26 | 1·16 | 2·6 |

Now, by giving the following articles of food we shall be able to supply the same amount and description of nourishment:—

| | | | *d.* | | Starch, &c. | Fat. | Albumen. |
|---|---|---|---|---|---|---|---|
| Oats | 5 lbs. | costing | 4· 8; | yielding | 2·3 lbs. | ·25 | ·55 |
| Hay | 3½ „ | „ | 1·75 | „ | 1·4 „ | ·14 | ·329 |
| Bran | 2½ „ | „ | 1·25 | „ | — | ·117 | ·482 |
| Carrots, | 84 „ | „ | 9· | „ | 8· | ·32 | 1·2 |
| | | | 16·80 | | 11·7 | ·845 | 2·561 |
| | | | 7 | | | | |
| | | | 12)117·60 | | | | |

Or 9*s.* 9½*d.* per week; being a saving of 10*d.* per horse per week.

In the above calculation I have valued the carrots at 20*s.* per ton, which price I think is high enough when we consider the large weight that can be grown of them. It will be seen, however, that while it will answer the farmer's purpose to consume them himself at such a price, yet when he can sell them for upwards of 25*s.* per ton it is more profitable to do so and feed his horses on other food. It is a bad plan to give horses a few

carrots only, or merely for a short time, as, being very partial to these roots, they are apt to refuse other food.

I have before observed that horses will generally eat very few swedes, but they differ in their tastes in this respect. They may, however, be allowed to eat what quantity they choose, as being at least equal to carrots with regard to nutriment, swedes are decidedly an economical diet.

Linseed has been proposed as economical feeding for horses, and in a few instances it has been tried. Linseed at 11*l.* 13*s.* 4*d.* per ton is just $1\frac{1}{4}$*d.* per lb., or about one-fifth dearer than oats. Estimating it in the same ratio as hay, we find that 100 lbs. contain of—

| | | | *d.* | | *s.* | *d.* |
|---|---|---|---|---|---|---|
| Albumen &c. | 20 lbs., | which at | $1\frac{1}{2}$ | per lb. makes | 2 | 6 |
| Fat, &c. | 20 „ | „ | $1\frac{1}{2}$ | „ | 2 | 6 |
| Starch, &c. | 36 „ | „ | 1 | „ | 3 | 0 |
| Making for 100 lbs. of linseed . . . | | | | | 8 | 0 |
| Now if to this we add one-fourth as in the case of beans . . . . . . . | | | | | 2 | 0 |
| We have . . . . . . . | | | | | 10 | 0 |

Which is very near 10*s.* 5*d.*, the cost of 100 lbs. of linseed at $1\frac{1}{4}$*d.* per lb.

It thus appears that linseed is somewhat dearer feeding than beans, a difference however which may readily be met by the superior value of the manure made from linseed. However valuable the large per centage of oil may be for fattening purposes, it is doubtful whether this oil is equal in value to albumen for a horse in work; and if not, beans must have the preference. The peculiar value of linseed is, however, to assist other nutritious food, such as straw, and thus by being made into a jelly and poured over and mixed with the straw when cut into chaff, to render it not only more palatable but more nutritious and better adapted for the animal; so that when hay is dear or scarce the use of linseed is exceedingly desirable. So likewise when hay has been deteriorated from being made in unfavourable weather, the addition of linseed-jelly makes it both palatable and nutritious.

The value of barley-straw, estimating it at the same ratio as clover, may be put down at 2*l.* 13*s.* 4*d.* per ton for feeding horses. As, however, it is, in proportion to the nutriment contained, considerably more bulky than hay, and therefore involves more muscular exertion and a greater effort of the digestive organs, it will be proper to estimate it as much lower, as we value hay lower than corn in proportion to the nourishment contained. Accordingly we must estimate it at only 40*s.* per ton, unless indeed it contains

a tolerable quantity of clover, which raises its value in proportion to the clover contained. Peas-haulm is exceedingly nutritious, and when well made is nearly as valuable as hay, for which therefore it may be readily substituted.

Young gorse is also a profitable food for horses, and when bruised in a proper machine, is very nutritious and palatable.

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Having now gone through the various articles of food, and given their theoretical value according to the amount of nutriment contained, a mode of estimating which I believe to be correct, and consistent with the results of practice, so far as with our imperfect data these results can be arrived at, I proceed to give some actual statements of the feeding of farm-horses, derived from personal knowledge of the cases in question. On a clay-loam farm in a good state of cultivation where the horses are in good condition, and the work though regular, yet harder than usual, particularly during seed time, and where two horses only are used in a plough, the following is the mode of feeding:—

During the dead of the winter, between wheat and spring sowing, commencing about the middle of November, and terminating in March, the horses are only allowed a bushel and a half of oats each, with barley-straw *ad libitum*; with this small quantity of oats a large amount of straw is consumed, amounting to 37 lbs. daily. The horses are not, as in many instances, sent some miles into a neighbouring town for the purpose of bringing out a load of inferior dung, but are more usefully employed at home. On this farm straw is plentiful and of the best kind, being well intermixed with clover, whilst hay is scarce, being required for sheep and cattle. The work at this period of the year is also very light. The cost of this feeding may be considered to be per week:

| | *s.* | *d.* |
|---|---|---|
| Oats 1½ bushel . . . . . | 4 | 6 |
| Straw 1¾ cwt. at 2*s*. . . . . | 3 | 6 |
| Swedes 42 lbs. . . . . . | 0 | 4 |
| | 8 | 4 |

As the work of spring comes on, the feeding is gradually improved till it reaches—

| | *s.* | *d.* |
|---|---|---|
| Oats 2 bushels . . . . . | 6 | 0 |
| Beans 1½ pecks . . . . . | 2 | 3 |
| Hay, not being clover, about 1 cwt. . . | 4 | 0 |
| | 12 | 3 per week. |

Barley and turnip sowing being pretty well over, and green food becoming abundant, and the work light,—

| | s. |
|---|---|
| The corn is reduced to one bushel . . . | 3 |
| Green food *ad libitum*, which is very difficult to value, but say . . . . . | 5 |
| Making per week . . . . . . | 8 |

As the wheat-sowing approaches, the same feeding is given as in the spring, costing, as then, 12*s.* 3*d.* per week.

| | | | | s. | d. | |
|---|---|---|---|---|---|---|
| Thus we have for | 3 months | the weekly | expense of | 8 | 4 | per week. |
| ,, | 3 | ditto | ditto . . | 12 | 3 | ,, |
| ,, | 3 | ditto | ditto . . | 8 | 0 | ,, |
| ,, | 3 | ditto | ditto . . | 12 | 3 | ,, |
| | | | £2 | 0 | 10 | |
| | | Averaging per week . | . . | 10 | 2½ | |

Or £25 8*s.* 8*d.* per annum.

This amount varies of course with the value of oats and other provender, and is more frequently below than above the estimate I have given. The horses thus fed are kept in good condition, and are able and willing to perform any work they are required to do. Of course there is some variation as to the time at which these changes of feeding begin or end, according to various circumstances: green-food, for instance, usually lasts a month or two longer than the time above stated, but the difference of expense is not material.

On another farm the following is the system of feeding adopted:—

| | s. | d. |
|---|---|---|
| 13 weeks on 1½ bushel of oats . . | 4 | 6 |
| 2 pecks of beans . . | 3 | 0 |
| 1½ cwt. of hay . . . | 6 | 0 |
| | 13 | 6 |
| 13 weeks on 2½ bushels of pollard. . | 2 | 1½ |
| 2 pecks of bruised beans . | 3 | 0 |
| Straw . . . | 1 | 9 |
| 70 lbs. of swedes . . | 0 | 8 |
| | 8 | 6½ |
| 13 weeks on 2½ bushels of pollard . . | 3 | 1½ |
| 2 pecks of bruised beans . | 3 | 0 |
| 1½ cwt. of hay . . . | 6 | 0 |
| | 12 | 1½ |
| 13 weeks on 2 bushels of bran . . | 2 | 0 |
| 1 peck of beans . . | 1 | 6 |
| Cut clover, tares, and pasture | 4 | 6 |
| | 8 | 0 |

The objection to this mode of feeding arises from that which I have before pointed out, viz., that bran and beans do not supply the constituents of oats, which the horse requires.

Another method of feeding adopted by another party is the following:—

| | | s. | d. |
|---|---|---|---|
| 13 weeks on $1\frac{1}{2}$ bushel of oats | . . | 4 | 6 |
| 1 peck of beans | . . | 1 | 6 |
| 1 cwt. of hay | . . . | 4 | 0 |
| | | 10 | 0 |
| 13 weeks on 2 bushels of oats | . . | 6 | 0 |
| 1 peck of beans | . . | 1 | 6 |
| 1 cwt. of hay | . . . | 4 | 0 |
| | | 11 | 6 |
| 13 weeks on 1 bushel of oats | . . | 3 | 0 |
| Clover, vetches, &c. | . | 5 | 0 |
| | | 8 | 0 |
| 13 weeks on 1 bushel of oats | . . | 3 | 0 |
| Clover | . . . . | 4 | 0 |
| | | 7 | 0 |

This statement of feeding is preferable in its arrangement to that previously described, but is still insufficient in point of nourishment for horses in full work, and is calculated to keep them under *par*. The first statement of horse-feeding, though more expensive, yet considering the condition of the animals, and the amount of work accomplished, is in the end the most economical.*

With regard to the medical treatment of horses, it should be borne in mind that "Prevention is better than a cure," and to use an old saying, "a stitch in time saves nine." To follow out these homely yet wise old proverbs, there is no better plan than to select a respectable and certificated veterinary surgeon, and pay him a moderate annual composition to attend and find medicines for all the horses on the farm. There is no more dangerous plan than that very frequently pursued of employing the village farrier to attend slight illnesses, with the intention of calling in a veterinary surgeon in difficult and dangerous cases. It requires all

* An excellent addition to this is to give every Saturday night a large bran-mash, in which an ounce, each, should be mixed of nitre and sulphur. Every sportsman knows the value of a warm mash to his hunter after a hard day's fox-chase; and if given to a cart-horse after heavy road-work it will be found equally advantageous.—F. Burke.

the tact and talent of a professional man to discriminate between slight and dangerous disease; for the latter often assumes symptoms so masked and obscure, as to require the utmost knowledge and experience to detect, and the unwary, in many instances, may consider the animal in little danger when he may absolutely be in the jaws of death. Now surely if the ignorant man is incompetent to treat an obscure and dangerous case, he is also unable to distinguish between such a case and one unattended with danger, and yet it is he or the farmer himself that must decide on the character of the case, and the propriety of seeking further advice. The writer has known several instances in which the farrier has confidently foretold the recovery of the horse when he has absolutely been in a dying state. One instance is very familiar to his recollection, in which the farrier arrived post haste, and almost without condescending to examine into the symptoms, immediately put into practice his round of remedies, *bleeding, blistering, rowelling, and clystering,* and then resting from his labours in a corner of the stable, whistled complacently, and foretold the speedy recovery of the animal. The words had scarcely issued from his mouth, when the poor brute that had been dying all the time he had been thus needlessly tortured, fell forward, and with one severe struggle expired.

The advantages in favour of compounding on the principle of insurance for the medical attendance of farm-horses are various: disease may be often prevented by early attention, dangerous disorders may be checked in the bud, and severe or incurable illness or lameness may thus be prevented. Medicines, with proper directions, may be left, so as to be administered immediately in sudden cases, as, for instance, in spasmodic colic; and thus the interest of the farmer and the veterinary surgeon may both tend towards one and the same object, *i.e.*, the prevention of disease. If any epidemic should break out (the horses being contracted for), the expense of treatment is moderate and limited, which is so much the better for the farmer; and if the horses should continue free from disease, it is so much the better for both parties.

With regard to the stabling of farm-horses, it should be comfortable without being too hot, and well ventilated without being draughty. Means should be afforded at the upper part of the stable (but not just over the horses' heads) for the exit of the heated and impure air, and if this be done we need not trouble ourselves about affording inlets for the pure and cool air; it will enter quickly enough we may depend on it. In addition to ventilation there ought to be sufficient light afforded by means of windows, which should be made to open so as to be used in summer for keeping the stable cool. They should, however, be provided with shutters, or lattices, to exclude the light. For after horses

have been hard worked during a long summer's day, the sooner the stable is darkened, after being dressed and fed, the better, so as to induce them to lie down and go to rest.

It is a very bad and thriftless economy in building a new stable to stint the room afforded to each horse. A dozen horses may be rendered uncomfortable and unable to take their proper rest, merely for the sake of making the stable hold one additional animal. Where full-sized horses are kept, six feet in width should be allowed to each, and stalls * should by all means be preferred where practicable. There are few persons who have been much used to horses but who can call to their recollection broken legs or other fatal accidents arising from the want of separation between each horse. Besides which, no two animals feed alike—some are slow, others are quick and ravenous. By feeding indiscriminately the former is robbed of his corn, and the latter is rendered still more ravenous by the hope of getting some of his neighbour's, and consequently does not properly digest his food, and thus both animals are injured. Another evil also arises from this faulty system. One of the earliest symptoms of the majority of internal diseases is a loss or failure of the appetite. If horses are fed in separate stalls, the carter can at once discover a horse who is off his feed; but when fed from the same manger, the gross feeders will take care not to leave any corn behind. Many horses fall off in their feeding, on hard work, from constitutional delicacy, without being at the same time in ill health; but if a handful of salt be sprinkled among his oats, it is inconceivable how much it will coax his appetite. The best situation for the racks and mangers is on a level with each other, the upper part being about 3½ feet from the ground. The racks, however, should not go down to the ground, and should be only large enough to hold about 20 lbs. of hay.

The best material, particularly for the mangers, is iron, which in the end will be found the cheapest as well as the cleanest.

The stall should be about nine feet in length, and the lowest part five feet in height. Where full-sized stalls cannot be given, quarter stalls separating the mangers, and a few feet further back, may be used as substitutes. They will serve to prevent one horse robbing another of his food, and will also economise room, and prevent biting, but they will not secure one animal from being kicked by another. When these short stalls are used there should always be a full-sized stall at each end of the stable, into which a vicious horse can be put. With regard to the flooring of cart-stables, it should consist either of brick wood. The latter is the cleanest

* I prefer a loose box for each horse, or each pair of horses, with a small open yard attached, in which a trough for water should be fixed. The door from the box into the yard may be closed whenever it is expedient to do so. —PORTMAN.

and makes the warmest layer, but it should consist of oak-blocks or very hard wood, to prevent the absorption of moisture. From the great abundance of timber in the north of Europe, the stalls are mostly planked, and, in well-built stables, the lower part of the boarding is slightly grooved, to carry off the urine—this both for horses and working oxen; the latter of which are there never provided with litter. The pavement may be laid with a gentle declivity of about two inches from the front to the back part of the stall, and gratings should be placed behind for the passage of the urine into an underground drain, conveying it to the tank or manure heap. With regard to the litter, it is well to remove the droppings from the horses much oftener than is generally done, and not to allow them to tread on them. By so doing much litter is saved, and cleanliness and health promoted. It is also an excellent plan to scatter powdered burnt gypsum on the floor of the stable two or three times a-week. The expense is trivial and will be entirely repaid by the retention of much of the ammonia of the urine, whilst the floor behind the horses will appear as clean as a new hearth-stone. If the floor of the stable be bricked, it is also a very good plan to wash it out occasionally with water saturated with gypsum.

Having now gone through the various branches of our subject, I must conclude with the hope that what has been written may in some slight degree tend to the improvement of the breed, the comfort, and the management of the noblest of domesticated animals; believing that these ends may be accomplished, not only without any pecuniary sacrifice, but with decided advantage to the agricultural community.

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## ADDENDUM.

### *The Show of Horses at York.*

Excellent as have been many of the previous shows of the Royal Agricultural Society of England, it must be conceded that, so far as it relates to horses, the exhibition at York surpassed them all. Nay, we think we are justified in making the bold assertion that, taking it as a whole, it was the finest show of horses of the kind ever brought together in this country, or perhaps in the whole world. This superiority is to be mainly attributed to two facts: one being that the show in question was held in a district celebrated beyond all others for its various breeds of horses, and that an unusually large number were brought together by the very attractive bill of fare which the Royal Society were enabled to offer through the liberality of the Yorkshire Agricultural Association, which body, instead of holding their accustomed Annual Meeting, presented to the Royal Agricultural Society the sum of 300*l.* This sum the Council resolved on devoting principally to Yorkshire purposes, and thus the department of horses came in for the liberal share of 210*l.*, which was consequently divided into eleven prizes, and was thus the means of creating seven additional classes. Although the exhibitors for these extra prizes were confined to Yorkshire (an almost unnecessary distinction), there was a very numerous display of horses, which, whilst it increased the variety, added greatly to the attractions of the show-yard.

In giving a brief account of the show of horses, it will be more convenient to notice them in the order arranged by the Society, as thus taken systematically the classes will more readily revert to the minds of the very numerous visitors of the show, very many of whom are no doubt readers of the Journal. Entering the yard, and passing to the extreme left, we came to Class 1, in which two prizes were awarded for the best and second-best stallion of any age, for agricultural purposes. The show of horses in this class embracing no less than twenty-eight stallions, being fifteen more than were shown at Northampton in the same class, was certainly an admirable exhibition. They differed from the Northampton horses in one striking peculiarity; viz., that whereas the latter were for the most part heavy horses closely bordering on the dray, the York horses rather tended to an opposite extreme. The locality of the two meetings readily accounts for this peculiarity; and there were several horses at the Northampton meeting that were condemned as too heavy, whilst at York some otherwise splendid animals were neither honoured with prizes nor commendations, because they were too light or light carcassed. This may explain the reason why some horses that appeared to be decorated with the medallions of former prizes at local meetings were not successful at York. One of the prize-horses at Northampton, and many others, were 8 feet in girth; whilst 7 feet 7 inches was the utmost that could be found at York. Again, one of the smallest-bodied horses at Northampton was 7 feet in circumference, and this was a Cleveland that might have been showed as a carriage-horse; whilst at York several professed cart-horses were several inches less. On the whole, however, the York horses were much more decidedly agricultural animals than those at Northampton. The Suffolk horses were remarkably successful, carrying in the class we are noticing both first and second prizes. The prize horse, which proved to be the property of the Marquis of Downshire, was certainly a very perfect animal: strength, symmetry, and activity were here all combined; the only fault that could be found (if fault it could be called) was that he was a shade too small, and yet he was an admirable specimen of an agricultural horse.

The second prize horse was larger, but inferior to the first in activity and symmetry.

There were some very superior grey horses exhibited in this class, one of which was highly commended. Before we leave this class, it is proper to remark that there were no less than eleven three-year old stallions exhibited in it; whilst at Northampton there were only two throughout the whole show, although at the latter place stallions of this age were shown in a separate class and were entitled to a prize, which at York was not given. It was probably owing in some measure to the small number of three-year old horses exhibited at Northampton, and to the Judges having withheld the prize from insufficient merit, that no prize was offered to this class at York; whether any alteration should take place in this respect may be a matter of consideration.

The next class was for stallions for getting *dray-horses*, a new class for which no prize had previously been given. The reason for offering this new prize was, we understand, the following:—At the Northampton meeting there were many horses possessing considerable merit, but whom the Judges were prevented rewarding in consequence of the very proper instructions they received from the Council, that for agricultural purposes the produce of these horses were required. This was strikingly shown in the class of two-years old, amongst which was a remarkably fine black colt, possessing activity and almost every other desirable qualification, but with one drawback, and that was his massive size. If it were not for this the Judges would unanimously have awarded him the prize, but contented themselves with highly commending him as a *dray-horse*. This colt proved to be the son of a mare that, with a foal by her side, gained a first prize at the same meeting; and it was in great measure owing to this animal that the class for dray-horses was created. Yorkshire, as we before remarked, is not so favourable a locality for heavy

horses, and consequently this class did not fill very well, there being but four horses shown, although there were seven entered. Three of these horses, however, possessed a good deal of merit, and the prize was without hesitation awarded to a fine black three-year old horse possessing great activity and size, and strength that the heaviest London dray could not daunt or the wealthiest London brewer fail to admire. We at once recognized in the winner our old, or rather young, friend that had excited our admiration at Northampton as a two-year old. There was a pleasure in awarding a prize to this horse, inasmuch as by thus rewarding and encouraging him we were assisting in propagating the excellences of the breed of dray-horses without their striking faults, viz., bad action, hairy legs, and ring-bones, from which several iniquities the horse in question was remarkably exempt.

The next best horse in this class was a Clydesdale, possessing great strength, activity, and much merit generally; he was, however, too active for a dray-horse, and would, no doubt, if placed with three London dray-horses in a team, do nearly all the work himself. Though large he was active enough for an agricultural horse, and in this class he ought to have been shown, where he would have stood a fair chance for a prize. We dwell the longer on this animal because he was almost the only Clydesdale horse in the whole show. It is difficult to account for this, for a few years since this breed was cried up as the very best for farming purposes, and no doubt the breeders of those animals think so still. We are sorry, therefore, that they had not spirit enough to enter their horses in competition for the Society's prizes, which are open to all the world. York was surely as near the Clyde as it is to the Stour of Suffolk, and I am sure the Society would have gladly welcomed competitors north of the Tweed.

The class of two year-old horses for agricultural purposes was not quite so good nor so numerous as at Northampton. At the latter show there were fifteen, and many of them of considerable merit; at York there were only eight exhibited, although two prizes were offered instead of one, as at Northampton. There was, however, a good deal of merit in this class, for the Judges awarded three commendations, besides the two prizes; and it is creditable to their native county to find that four out of the five thus rewarded were bred in Yorkshire. The class of mares with their foals, for agricultural purposes, was rather more numerous and better than at Northampton; besides the two prize animals, two were commended, of whom one was a Clydesdale mare.

The class of two-year old fillies, though numbering only three, possessed considerable merit, and the two prizes were borne off by the same noble competitor, who succeeded also, in the class just mentioned, in gaining another prize.

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## XIII.—*On different Varieties of Wheat, and the Advantage of thick Sowing.* By W. Loft.

*To Mr. Pusey.*

Sir,—As there are many conflicting opinions relative to the best varieties of wheat, and also as to the requisite quantity of seed, it seems highly desirable that careful experiments should be made in different localities and on various soils, in order that a correct judgment may be formed as to the sort of wheat and the quantity of seed best adapted to different soils. With this view, then, I venture to give you the result of two experiments made

by me in the growth of wheat: the first was in 1844, and the second last year, 1847. The soil of this district, viz., the Lincolnshire Marshes, consists principally of a loamy clay on a strong tenacious clay subsoil, and is what is generally termed a good wheat and bean soil. The old system of cropping used to be wheat, beans, and a naked fallow, manured for wheat again; drainage generally very bad; the consequence was, that the average yield of the wheat-crops did not exceed from 24 to 28 bushels per acre. The general drainage of the country has, of late years, been so much improved, that thorough draining can be effected where before it was quite impracticable, and the tithes, which before were a great barrier to the plough, are for the most part commuted—consequently large breadths of old grass-land are being taken up, which of late years had been very unprofitable, and will now produce abundance of corn. This, together with a greatly improved cultivation of the old arable land, is rapidly increasing the produce of this country, which is still capable of a much further increase, if tenants would generally employ more capital, and landlords would give up their predilections for poor grass-land. On this point I am happy to say we improve, although still very much remains to be done. On most of my land I grow wheat, alternately with roots or leguminous crops; and I find that, with the land being now laid dry, and improved cultivation, my crops have greatly increased, as will be seen by the following statement. In 1844, I had planted in the same field twenty-six varieties of the best wheats I could procure; these were carefully put into the ground by hand, after a crop of rape eaten off with sheep; eight of these varieties were white wheats, the remainder red. In all the white sorts there was a considerable quantity of smut, two or three of the finer sorts being much the worst; whereas amongst the red only three cases occurred, and two of those only very slightly affected with smut. From those that were free I selected of the best, and subjoin the result:—

| | Bush. | Pks. | | lbs. | |
|---|---|---|---|---|---|
| 1. Marigold . . . | 56 | 3 | per acre | 63 | per bushel. |
| 2. Bristol Red . . . | 48 | 0 | ,, | 62½ | ,, |
| 3. Holderness White-Chaff . | 49 | 2 | ,, | 62½ | ,, |
| 4. Britannia . . . | 40 | 1 | ,, | 62 | ,, |
| 5. Spalding's . . . | 40 | 0 | ,, | 62 | ,, |
| 6. London Red . . . | 39 | 3 | ,, | 63¼ | ,, |
| 7. Creeping . . . | 41 | 1 | ,, | 63¼ | ,, |
| 8. Cluster . . . | 47 | 3 | ,, | 63 | ,, |
| 9. Clover's . . . | 41 | 1 | ,, | 63¼ | ,, |
| 10. Syer's . . . | 46 | 2 | ,, | 61 | ,, |
| 11. Soothy's . . . | 50 | 1 | ,, | 56 | ,, |
| 12. Egyptian Mummy . | 45 | 0 | ,, | 62 | ,, |

The quantity of seed used was at the rate of 5 pecks per acre; and the average yield, as will be seen, was about 45 bushels 2 pecks per acre. The remainder of the same field (15 acres) was drilled in the usual way, with 8 pecks to the acre of marigold wheat, and it yielded rather over 57 bushels per acre, weighing 63 lbs. per bushel; there was no difference either in land or management, except that the twelve varieties had a little more care and labour bestowed upon them in weeding and hoeing than the remainder of the field. This result is at variance with the opinion of the advocates of thin sowing * as to quantity of seed; and indeed I do not believe that any specified quantity of seed can be laid down as the proper quantity for all descriptions of soil and climate; practice and experience alone must be the guide; for although I am willing to admit that wheat tillers well on this soil, I find from repeated trials that it is not safe to sow much less than 8 pecks per acre on an average. I now generally begin seed-time with 7 pecks as the minimum, gradually increasing, as the season advances, to 9 pecks per acre.

My next experiment was with five varieties, grown last summer in the same field as before, about 3½ acres of each sort, drilled on bean-stubble, with a slight dressing of lime and soil, 7½ pecks of seed per acre; result as follows:—

| | Bush. | Pks. | | lbs. | |
|---|---|---|---|---|---|
| 1. Marigold . . . | 57 | 0 | per acre | 63 | per bushel. |
| 2. Spaldings . . . | 51 | 0 | ,, | 62 | ,, |
| 3. Bristol Red . . . | 43 | 1 | ,, | 61½ | ,, |
| 4. Piper's Thick-set . . | 39 | 1 | ,, | 61 | ,, |
| 5. Colne White-Chaff . | 40 | 1 | ,, | 57 | ,, |

I have furnished Professor Way with specimens of the above five varieties for the use of the Royal Agricultural Society. I have mentioned here such particulars as strike me of importance; and if it is in my power to add any further information, I shall be most happy to do so. I have, &c., W. LOFT.

Trusthorpe, Lincolnshire, January 17th, 1848.

* I feel convinced that very many circumstances, to be determined alone by the tenants of the respective farms, must decide the quantity of seed to be sown on the respective localities.—W. MILES.

## XIV.—*On the Farming of the West Riding of Yorkshire.* By JOHN H. CHARNOCK.

### PRIZE REPORT.

In order probably, amongst other reasons, the better to provide for the local administration of the affairs of so extensive, and even at that time so important a county, Yorkshire was at an early period divided into three integral portions called Ridings, the North, the East, and the West; and these again were subdivided into smaller districts under the title of Wapentakes, a term synonymous with the Hundreds of other counties, and I believe exclusively applied in the North. Of these Wapentakes the West Riding, of which it is my present purpose to speak, contains ten, viz. Staincliffe, Claro, Skyrack, Barkston Ash, Morley, Agbrigg, Staincross, Osgoldcross, Strafforth, and Tickhill and the Ainsty of York. It is separated on the north by the rivers Ure and Ouse, from the North Riding; on the east by the Ouse and Humber, from the East Riding; on the south by the river Don (the division from Lincolnshire), and the counties of Nottingham and Derby; and on the west it is bounded by Cheshire, Lancashire, and Westmoreland. The extreme length, from east to west, is about 95 miles; and the average breadth about 26; comprising, according to the Official Report of the last Census, an area of 1,648,640 statute acres, computed to realize an annual value of 1,449,000*l.*; equal to about 17*s.* 7*d.* per acre. By the same authority, the population in 1841 was 1,154,101; being an increase of more than double since 1801, and upwards of 18 per cent. over the return of 1831.

Although, in the general treatment of the subject, I might possibly have adopted a somewhat different arrangement, I shall, nevertheless, regarding with befitting deference all well-considered regulations, confine myself as strictly as may be to the prescribed order of matter, taking such licence only under the several heads as may be requisite to render this Report as accurate and comprehensive as the usual limits will admit.

First, then, as to *the Character of the Soils.*—In attempting to describe the various soils to be met with over such an extent of country as this Riding presents, it will, I conceive, be as unnecessary as impracticable within ordinary compass, to enter into more minute detail than shall suffice to convey such a generally correct knowledge of its surface, as will enable the reader to appreciate the practical advantages of such peculiarities of cultivation in the several localities which may be brought under his notice, as well as to exercise his judgment on the value of any suggestions for improvement which may be presented to him in

# OUTLINE
OF THE
## GEOLOGY OF THE WEST RIDING
OF
# YORKSHIRE.


**REFERENCES TO PLACES ON THE MAP.**

1. Sedberg.
2. Dent.
3. Ingleton.
4. Settle.
5. Kettlewell.
6. Middlesmoor.
7. Pateley bridge.
8. Skipton.
9. Clitheroe.
10. Keighley.
11. Ripon.
12. Boroughbridge.
13. Ripley.
14. Knaresborough.
15. Harrogate.
16. Ilkley.
17. Otley.
18. Harewood.
19. Witherby.
20. YORK.
21. Tadcaster.
22. Aberford.
23. Leeds
24. Bradford.
25. Halifax.
26. Hebden Bridge.
27. Ripponden.
28. Huddersfield.
29. Dewsbury.
30. Wakefield.
31. Normanton.
32. Pontefract.
33. Selby.
34. Goole.
35. Snaith.
36. Thorne.
37. Haddlesey.
38. Heck.
39. Hensall.
40. Doncaster
41. Woolley
42. Staincross.
43. Barnsley.
44. Wortley.
45. Peniston.
46. Saddleworth.
47. Sheffield.
48. Tickhill.
49. Bawtry.
50. Rotherham.
51. Green Hammerton.
52. Whixley.
53. Cawood.
54. Sherburn.

○ Penygant Hill.
⊕ Wharncliffe Wood.

**ARRANGEMENT OF STRATA.**

A. Mountain Limestone.
B. Coal.
C. Millstone Grit.
D. Magnesian Limestone.
E. New Red Sandstone.
F. Alluvial.

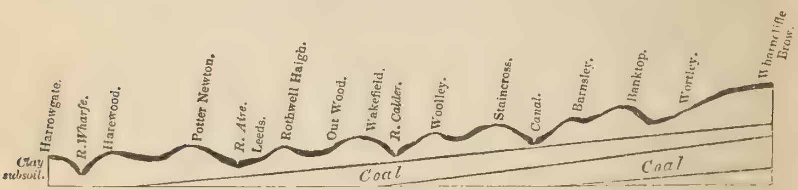
this report; and although in the endeavour to make such a description full and intelligible it may be difficult to avoid some prolixity, yet by basing it on the general geological features as they occur, *seriatim,* I shall hope to carry the mind's eye of the reader along with me, and with the aid of the accompanying Map of the Riding, perhaps, too, of his own more practised knowledge of the characteristics of each formation, lead him to a tolerably accurate conclusion as to the nature of the soils of this important manufacturing and agricultural portion of the county.

The most prominent geological feature of this Riding, as most people are probably aware, is that great Coal-formation which comprises so considerable a portion of its entire area; and from whence is derived the primary source of that manufacturing industry which has secured for the numerous productions of its enterprise and skill so well-merited a celebrity throughout the world. The broadcloths of Leeds, the cutlery of Sheffield, the worsteds and stuffs of Bradford and Huddersfield, the linens of Barnsley, the blankets of Dewsbury, the pig and bar-iron of Rotherham, Low Moor, &c., with their innumerable adjuncts and appliances, have each and all their lives' sinews from the apparently inexhaustible supply of this greatest of national treasures. Unlike some of the more northern coal districts, where the immense value of the under-ground product seems to have operated rather as a reason for the almost total disregard of the surface, than as an inducement for any cultivation of the soil—as if superiority of intellectual endowment was an exemption from all the proprieties of external deportment—the more grateful sons of this locality have bestowed upon mother earth a culture which, if not of the highest order, is at least perhaps commensurate with the time that could be spared from more immediately profitable occupations.

The Yorkshire coal-field embraces at least one-third of the West Riding, extending from its southern boundary to some few miles north of Leeds, with a breadth of from 20 to 30 miles. The undulation of surface which it exhibits forms a constant succession of hill and dale; and rising as the backs occasionally do to more than ordinary altitude, a varied landscape of much beauty and richness is constantly presented to the eye of the traveller. Commencing at Harrowgate, where the indications of the mineral wealth of the formation seem * first to manifest themselves, there is a succession of steplike configurations of surface gradually ascending into Derbyshire and Cheshire; the general dip of the strata being to the north-east, until it reaches

* The mineral waters of Harrowgate, both sulphate and chalybeate, seem to attest this; and it is probable that coal and iron would be found at no great depth, though they might be of inferior quality.

the comparatively narrow belt of the magnesian limestone, separating it from the lower levels of the Vale of York, and the confines of the eastern boundary of the Riding. By far the largest portion of the soil on this formation is of a strong character, resting on the ordinary subsoil of yellow clay so general in the coal districts. In those parts, however, where the sandstone beds and shale approach the surface sufficiently to render it naturally dry, a good, and in many places very productive, soil is found. The clay with its strong soils usually covers the valleys and the entire rise in the lower swells, but in the more elevated places extending only a limited distance up the rise, where the sandstone comes through, and a friable soil commences; as though the aluminous particles had slipped or been washed down from the steeper inclinations and formed the clay subsoil of the lower levels. The following sectional sketch of the formation from Harrowgate to Wharncliffe may, perhaps, more fully illustrate the manner in which the circumstances we have just spoken of occur. The top irregular line shows the clay subsoil:—




Thus from Harrowgate to Harewood is a strong clay soil, and most of it thin and poor: at Harewood, where the rise occurs, and the rock approaches nearer the surface, the land is somewhat less strong and of superior quality; the clay, however, soon appears again, and with it a much less fertile soil, until we come to Potter Newton and Chapel Allerton, where the rock comes to the surface, and from the pounding of which a yellow sand is made and sent into Leeds in considerable quantities, for the mere purpose of sprinkling on the kitchen floors of the better classes, and on the house floors of the lower orders; as if adding sand to dirt made cleanliness—

"put compost on
To make the weeds the ranker."

Leaving Leeds, which is situated in the valley, and where we again have the clay and stiff soil, the ground rises to Rothwell Haigh, at which point there is a tract of fine dry land, which by good management and an abundant supply of manure from Leeds produces heavy crops of swedes, barley, clover, and wheat. Many coal-pits are at work over this district. Passing Rothwell

we have the clay again over Wakefield Out-Wood, and to the town itself, where the sandstone rock, with a thick covering of shale and some clay at the surface, gives to the soil the character of a strong yet productive loam, which by tolerable care and tillage produces heavy crops of grass, corn, and vegetables; for a large proportion of the land in this immediate vicinity is in market-gardens, from which many of the more densely populated manufacturing towns of the Riding are almost exclusively supplied. Passing from Wakefield we find, as the ground gradually ascends, a greater proportion of dry and good land, and that, as the contour becomes more marked, the transitions from the friable soils of the sandstone to the stronger ones of the clay subsoils are more abruptly noticeable—the clay occupying its place in the valley, and the sandstone up the rise. With few exceptions, the dry land lies to the north-east, on the back of the strata; whilst that on the face side of the rise, to the south-west, is wet and springy, and of a much less fertile description. At Woolley, Staincross, and Barnsley these features are very perceptible; after which we meet with exceptions to this order in a considerable tract of the clay subsoils, interspersed with a saturated subsoil of light-coloured aluminous sand, and very wet, extending to Sheffield and up to Wortley, and thence forward, with but little variation, to the prominent point of Wharncliffe Brow; from whence is a most magnificent prospect towards Derbyshire and Lancashire, with the gorgeous carpet of Wharncliffe Wood spread out at the foot, and covering with its varied shades an undulating area of about 2000 acres. There are, of course, many gradations in quality both on the strong and lighter lands of the coal-measures—from the poor thin soils of its strongest clays, to the 8 and 10-inch loams of the sandstone—but the same general order of succession occurs with much uniformity over the whole breadth of the formation, as is shown in the route I have selected for its illustration; and the reason for selecting which has been, that it is, probably, the one most immediately within the recognition of the general reader.

The next description of soil I shall proceed to notice is that resting on the Magnesian Limestone, previously referred to as bounding the coal-measures on the east. This narrow band enters the county from Nottinghamshire, at Bawtry, with a breadth westward of 7 or 8 miles by Tickhill and Sandbeck to the coal district, and extends northward across the West Riding, by Doncaster, Ferrybridge, Sherburn, Aberford, Wetherby, Knaresborough, and Ripon, with an average breadth of 5 or 6 miles. The porous nature of the rock, which in general comes near the surface, gives to the soil throughout the entire length of this formation a dry and light character; and although not devoid

of much pleasing undulation of surface, nevertheless does not present any very marked prominency. Speaking of this formation, Morton, in his work on soils, says, "From statements which have been repeatedly copied, that magnesian lime is pernicious to the growth of vegetables, we would naturally expect the soil of this formation, if it partakes in the smallest degree of the nature of the substance of the rock, to be sterile and barren; this however is not the case, for although the soil is in general thin on the magnesian lime, yet it is a good light soil for arable culture, and with manure produces good crops. From Nottingham to Boroughbridge this soil is profitably cultivated as arable land, and produces good turnips, potatoes, barley, and wheat." And no one who has travelled down the great North Road, which from Bawtry to Boroughbridge traverses almost the central line of this formation, but will be satisfied, from his own observation, that this account, if anything, tends rather to an under than an over estimate of the ready and economical productiveness of a very great portion of this land under fitting management.

We next come to notice the district comprised between the magnesian limestone and the rivers Ure and Ouse, which, from their confluence with the old river Don, form the eastern boundary of the Riding from that point to the city of Ripon. Although this portion is geologically considered as a continuation of the New Red-sandstone formation, there are parts which may, perhaps, be better distinguished as alluvial. Of these, that triangular area of low country formed by the old river Don, the Ouse, and the Thorne and Snaith Road, is one locality; and the other extends up the Ouse from the junction of the river Aire, past Selby, to that of the Wharfe at Cawood; the whole of which is flat, and of an alluvial character, and extending in breadth to the limestone formation.

The New Red-sandstone itself, with its distinguishing features, enters the county from Lincolnshire in a comparatively narrow stripe between Bawtry and Thorne, running, with little variation in that width, to the east of Doncaster. Thence it increases somewhat in breadth, and passes by Hensall and Heck to Haddlesey, where the alluvial flat intervenes as before mentioned, until it approaches Tadcaster, when it again shows itself and continues its course northward by Wetherby, Goldsborough, Whixley, Green Hammerton, to Boroughbridge and Ripon, with a breadth to the eastern boundary of the Riding. The soil at its southern extremity up to Doncaster partakes, for the most part, of that sandy-loam character which, without very much colour, sufficiently indicates the substrata. From Doncaster, by Hensall, and in parts of Haddlesey, it is of a still more sandy description; so much so as at Hensall and Heck to drift into the hedges and

ditches like snow on a dry windy day. After leaving Tadcaster it assumes more decidedly its distinctive nature, both in colour and substance; and in the district around Goldsborough, Whixley, Green Hammerton, Ouseburn, and Boroughbridge, is marked by very superior land, both grass and arable. It is here of a much more firm and loamy character than in the southern portion of the Riding; and being at the same time dry, and containing a large proportion of colouring, the peroxide of iron so beneficial to vegetation, it produces the most luxuriant crops of turnips, barley, seeds, or clover, and wheat. The pasture lands too of this district are of a superior order, possessing feeding properties of great value, and carrying a more than usual number of stock.

Before dismissing the consideration of this division of the Riding, it may be interesting to mention that, in the neighbourhood of Ripon, there seems to exist an under-stratum of gravel in this formation, through which a great body of water flows, and which, on two or three occasions within my own time, has, as it were, washed away so large a subterranean area as to cause the surface to fall in and leave circular-shaped disruptions of considerable size filled with water. On one of these occasions an honoured relation of mine was roused from dinner by the sudden appearance of his farm-bailiff at the window, in great trepidation, begging him to come instantly, for, as he said, "the water was coming into the stack-yard." In the middle of which, and within a short distance of the mansion itself, sure enough, the surface had disappeared (and with it a portion of a corn-stack) in an area of 5 or 6 yards in diameter, which was constantly enlarging by the boiling up of a great volume of water. Much exertion was required to save the remainder of the stack, as well as others that stood near. During the whole of the day, and for some time afterwards, it continued to enlarge, and, from not knowing where it might stop, created no little uneasiness. After a time, however, the action of the water ceased, and left a pond of 15 to 20 yards in diameter and of considerable depth, which remains in that state at this day. This occurred about 26 years ago; and within the last 10 or 12 years another has fallen in, a little to the north of Ripon, where the stream in the bottom can be seen flowing from the surface: this of course is not *filled* with the water as in the other instances. The surface in the neighbourhood presents many indications of similar outbreaks; and I have in my possession a note from an eye witness to a friend, describing one that took place in 1796, which has ever since been a pond of beautifully clear water, with very little variation even in the driest seasons.

We must now direct our course across the Riding from east to west, along the northern edge of the coal formation, from Tadcaster to the western boundary, and we shall pass through the

broadest end of the next geological field, the soil of which it is our purpose to consider, viz. that of the Millstone Grit. It extends from the northern extremity of the coal, through the centre of the Riding, to Middlesmoor, with an average breadth of probably 25 miles. There is also a branch of 6 or 8 miles in width to the west of the coal-field, and up to the division of the county from Lancashire, by Bingley, Haworth, Heptonstall, and Ripponden. Westward from Harrowgate and Ripley the surface assumes that more hilly contour by which we approach the high moorlands of this formation; the range continuing into Lancashire, and, through the North Riding, into Northumberland. The soil is generally of a poor character, and there is very little, if any, of it but what, from the loose nature of the decomposing rock and its comparative altitude, is very wet. On the higher portions there is peat; but not to so great an extent in this part of the range as further north and south.

Around the villages and hamlets, which in several parts, and particularly towards the Lancashire side, are much more thickly spread over this comparatively unproductive formation than might be supposed, most of the land is in grass, and from the additional care that is bestowed upon it, affords much good pasturage, and fair crops of hay. The arable land, from its excess of moisture, is very precarious in its return; but examples are not wanting to show that, when dry, its capabilities of production are little, if at all, inferior to other more favoured soils.

This last series rests upon, and is as it were the ascent to, the more irregular and mountainous formation of the Carboniferous or Mountain Limestone, which constitutes the western portion of the Riding, commonly known as the Craven district, and is the remaining locality for consideration under this head of our subject. Throughout its whole extent it presents a surface of irregular, and in many parts precipitous outline, rising as it approaches Westmoreland into a mountainous tract of very considerable altitude. In the neighbourhoods of Bolton Abbey, Skipton, Settle, Giggleswick, Malham, and Sedbergh, the prominency of the rocks, contrasting with the fertility and bright green verdure of the numerous valleys, each with its stream running through it, forms a scene of rich and ever-varying beauty, where the lover of the picturesque may study the effects of light and shade to his eyes' content. With few exceptions the soil is thin, but at the same time, from its peculiar properties, and being for the most part comparatively dry, it produces a herbage which, though short, is sweet and nutritious. In the valleys the soil is deeper, and by liming and tolerable grazing management has become some of the richest pasturage in the country. "The contrast," says Morton, "between the pasturage on this and on the sand-

stone is so great as to be perceived at a considerable distance." The peculiar property of the lime from this formation, and which is very generally and liberally applied, is no doubt the primary cause of this fertility. Possibly too, on the lower grounds, this may be aided by the frequent floods distributing in solution some portion of those properties which the lime possesses. The fertilizing effect of the water issuing from the rocks on this formation is very observable wherever springs break out, and are suffered to impart their virtues uncontrolled over the surface. A rich exuberance, greatly exceeding both in colour and quantity the surrounding herbage, is the invariable result. The water which flows from the famous intermittent spring near Settle, across the high road and over a portion of the adjoining field, attests the properties it contains for the edification of the observant passer-by.

I have thus endeavoured, as succinctly as may be, to describe the leading geological features of the Riding, and to make the reader acquainted with the character of their respective soils. And if, within such a compass, it has been found necessary to pass over some of those gradations in quality which, as everybody knows, exist in soils on the same stratification, I shall not, nevertheless, I trust, have failed to convey a tolerably correct idea of the various soils of the West Riding.

*The peculiarities of the agricultural management* is the next portion of the subject to be considered, and this we purpose doing in the same order of rotation in which the soils have been noticed. When it is remembered that within the limits of the coal formation are situated all the populous manufacturing towns of the county, it will not be thought singular that little or no general system of cultivation should be pursued beyond that which may be deemed the best for securing the greatest amount of marketable produce in the shortest time. Within the influence, for instance, of Leeds, Sheffield, Huddersfield, Bradford, Halifax, Barnsley, and Wakefield, every occupier adopts that rotation which he esteems most suitable to his own immediate requirements and those of the locality in which he is situated, unless he is confined by agreement to a particular course. The more abundant supply of manure which these places afford admits of his indulging in every variety and excess of cropping with less chance of injury to the land; for, however injudicious in many instances the succession may be, it will easily be conceived that by hard mucking the condition of the land may be maintained. The proportion of grass-land around all the places we have named very much exceeds the arable; and although some of it is rendered very productive, yet it has always appeared to me that it is generally much neglected, and not unfrequently deprived of

its proper share of manure tillage in order that the arable land may have the more. Much of this grass is mown year after year, until, notwithstanding its proximity to the dunghill, its produce is manifestly on the decline both in quantity and quality. Most of the arable land is, as I have said, cropped irrespective of system; potatoes, wheat, clover, potatoes, wheat or cabbages, is a common course. And again, white crops in succession with a green one every third or fourth year, is not uncommon. The green crops alternate between potatoes, swedes, red clover, tares and oats, carrots, cabbages, and cauliflower-brocoli, of the two latter of which fields of some extent are often to be seen, particularly in the neighbourhood of Wakefield and one or two other places. A continuous succession of wheat crops too is not confined to a solitary example. Within the last few days I have seen a crop of wheat now growing on a field at Horbury (and which certainly from present appearances promises to be a full one) that for the last 30 years has grown wheat every year, with four exceptions. The following is a correct "statement of the cropping of a field belonging to Mr. Wm. Holt, of Horbury, near Wakefield, situated on the banks of the river Calder; soil alluvial:"—

| | | | | |
|---|---|---|---|---|
| 1819 to 1824 | inclusive, | 6 | years, | Wheat. |
| 1825 . . | . | 1 | ,, | Beans. |
| 1826 to 1828 | ,, | 3 | ,, | Wheat. |
| 1829 . . | . | 1 | ,, | Barley. |
| 1830 to 1841 | ,, | 12 | ,, | Wheat. |
| 1842 . . | . | 1 | ,, | Fallow. |
| 1843 to 1845 | ,, | 3 | ,, | Wheat. |
| 1846 . . | . | 1 | ,, | Potatoes, slightly manured. |
| 1846 to 1848 | ,, | 3 | ,, | Wheat. |

Mr. Holt says, "The reason why I fallowed the land in 1842 was, that there were many wild oats got among the wheat; but at the same time the land, in other respects, was in as good condition as for many years before. I have not given this land any manure for 25 years, except about 4 dozens of lime and a few ashes, and it has averaged 13 and 14 loads of wheat, or 39 and 42 imperial bushels per acre. I have another close which I have sown 11 years out of 14 with wheat; and the other three years it had beans, barley, and turnips."

The ready markets and comparatively higher value of produce in these districts, coupled with the greater facility of procuring manure, not only stimulate the smaller occupiers within easy reach of the towns to what might otherwise prove an impoverishing course of cropping, but they also conduce to some of the larger and more enterprising farmers adopting a system which, a few years ago, would certainly have brought down upon them

the displeasure and apprehension of the owners of the soil, and probably the ridicule or contempt of their neighbouring occupiers. What, for instance, would have been thought of such a rotation as the following, and on what may be called rather strong than light soil, viz.:—

| | |
|---|---|
| 1st year. | Turnips eaten on. |
| 2nd ,, | Wheat. |
| 3rd } 4th } | Seeds and White Clover eaten on and limed the last year for |
| 5th ,, | Wheat. |
| 6th ,, | Wheat on the stronger land, and Barley on that which is lighter, |

which is now often practised on some of the best farms of the coal district? The following four-course shift is also very general, viz.—

| | |
|---|---|
| 1st year. | Turnips eaten on. |
| 2nd ,, | Wheat. |
| 3rd ,, | Red Clover—and limed for |
| 4th ,, | Wheat. |

Having given one instance of the successive, and it may be said successful growth of wheat, we must not omit to notice the practical confirmation of such a course by a gentleman residing 6 or 7 miles south-west of Wakefield, and occupying a considerable quantity of strong land. From his habits of business, and general ability to form a sound judgment on such a matter, coupled with his acknowledged caution in arriving at practical conclusions, I esteem his communication the more interesting and worthy of consideration. I refer to Mr. Henry Briggs, the intelligent and indefatigable honorary secretary of the Wakefield Farmers' Club, and the author of some very valuable papers read before that Society, whom I shall let speak for himself, by quoting the communication in full with which he has favoured me:—
"With regard to the system of growing wheat (says Mr. Briggs) year after year on the same land, effectively and profitably, I see no difficulty, except in keeping the land clean, and free from weeds. In one of our fields we have now had wheat 5 years successively, and it is again sown with the same crop. Last year, being the fifth, the crop was as good, if not better than any of the previous ones, and yielded 12 loads (36 bushels) of good merchantable corn per acre, of excellent quality. The means adopted have been, to pare the stubble as soon as possible after the crop was cleared away, then to collect and burn the same, along with any weeds and twitch that might be in the land. Afterwards to use a heavy drag or scarifier, which brought to the surface any remnants of stubble and weeds, which were again collected and burnt. The field was then ploughed, and either drilled

in the common way or sown broadcast, applying at the same time 2 cwt. of guano and 2 cwt. of salt, broadcast and harrowed in. This year we have followed the ploughs with a presser heavily weighted, in order to solidify the soil (which is rather light than otherwise), and then sown $2\frac{1}{2}$ bushels per acre broadcast. We have also applied this year, about 2 tons per acre of lime, spread over the stubble immediately after the crop is removed, and before the paring took place. The object of this was to assist in destroying the growing weeds by applying the lime in its quickest or most caustic state, and impairing the vitality of their seeds. I considered that the application of the lime so long before the introduction of the guano, destroyed its power of releasing the ammonia by its becoming a carbonate before that period, by the absorption of carbonic acid from the atmosphere. I mean to persevere in the same system on the field in question, and I feel perfectly satisfied that, so far from impairing the land, I shall render it much more fertile."

I am not aware of any other peculiarities of cultivation in the coal district of sufficient importance to be dwelt upon at further length; but I would direct the attention of proprietors and occupiers on this formation, to the farming of Mr. Johnson, of Chevet Grange, and of Godfrey Wentworth, Esq., of Woolley Park, to whom the Yorkshire Agricultural Society awarded the first and second prizes in 1843, for "the best cultivated farms:" the details of their management, along with that of the other competitors, is recorded in the Transactions of the Society for that year, and will repay a careful perusal by all who desire to farm profitably and systematically.

The magnesian limestone, running through the more exclusively agricultural districts of the Riding, is much less subject, in the cultivation of its soils, to those varieties and peculiarities in cropping which are induced by circumstances over the more variable and densely populated localities of the coal-measures. Being of a naturally dry and friable nature, this soil is well adapted for turnip husbandry. The usual rotation is the four-course of turnips, barley, seeds, and wheat, varying the grain crops occasionally, and substituting red clover for seeds. Peas are also grown on the deeper portions of this soil, and are a judicious and profitable adjunct in the rotation, large quantities being pulled green and sent to Leeds and other surrounding markets. The six-course shift is sometimes followed, and when conducted with skill and judgment is suitable for this land. I am indebted to Mr. Charles Charnock for the following account of his Holmfield House farm, near Ferrybridge, to which I would direct attention as one of the best specimens of thoroughly good farming that is to be met with, amongst the many which exceed mediocrity, on

this formation. The farm contains 520 acres; 400 being arable, and 120 grass. The general rotation is turnips, barley, seeds, wheat; varied by 20 acres each year, out of the 400, being subjected to the following cultivation.—After the wheat the stubble is cleared, manured, and sown with tares, which are cut for the horses the following spring. The land is then prepared and drilled on the flat with stone turnips (manured with about 10 bushels of bones per acre), which are eaten on with sheep. And the following year it is prepared and sown in the same way with swede turnips, manured in a similar manner. The wheat crops are always manured with rape-dust at the rate of about $1\frac{1}{2}$ quarters per acre. Mr. Charnock says, he finds guano on this soil does not answer for corn crops, and but very indifferently for turnips. He has grown good crops of turnips with nothing but sulphuric acid mixed with the ashes of the burnt weeds. Red clover has been grown here for 14 years, and in the adjoining township of Ferrybridge for 30 years, without the land becoming what is commonly called clover-sick. It is also worthy of especial notice, that the whole of this farm, although the soil is within a few inches of the limestone shale, has been subsoiled and trench-ploughed with the greatest manifest advantage—even to the doubling of the produce. Previous to this operation the crops were burnt up with a very moderate degree of drought; but during the last two dry seasons, not a failing spot has been visible in the corn crops.

There is in this locality the cultivation of one plant which, although of limited use, may be properly noticed here, inasmuch as it seems to be grown wholly on the limestone soil of this formation. I allude to licorice, which, as every one knows, is peculiar to the neighbourhood of Pontefract, and requires a considerable depth of soil to produce it in perfection. For the information of those who are unacquainted with it, I may state that in general appearance it very much resembles a bunch of young ash saplings growing in slender upright twigs of four or five from the same root, to about 2 feet in height. It is the roots only that are used; and as these are generally from 2 to 3 feet in length, an idea may be formed of the depth of soil necessary for their perfect growth. This suitable thickness of soil is met with at the side and foot of those numerous short rising grounds surrounding the town of Pontefract; and it is pretty manifest that the excess of depth has arisen either from the soil slipping down from the rise above, or from artificial causes. The mode of management too favours the necessary depth: when first planted it is set in a tolerably deep trench, and is subsequently earthed up like celery to a height of 18 inches and 2 feet in the last year of its growth. It is the practice to plant cabbages in the furrows, which, from the

facilities for earthing up, and the protection thus afforded them, come to perfection some weeks earlier than those in ordinary market-garden grounds. Large quantities are thus grown, and sent to Leeds and the other large towns for sale, where they meet with a ready market.

On those alluvial soils bordering the new red-sandstone, and within the influence of the rivers which have been previously mentioned as forming their limits in the West Riding, in addition to the usual corn and green crops, flax, teazles, woad, and carrots enter largely into the rotations. Mustard is also frequently grown, and in a favourable season, when well housed, is not only a paying crop in itself, but an excellent preparative for the succeeding wheat crop. In the neighbourhoods of Goole and Selby potatoes are cultivated very extensively on the better portions of the warp soils;* and as these inland ports afford great facilities for shipping this produce to the manufacturing districts, as well as to London, and also for the return of manure, this root alternates on the same land with an oat or wheat crop; and is not unfrequently grown many years in succession. I was informed not long ago by a respectable person at Selby, that for some years past his annual profit from potatoes, out of one field of nearly 4 acres, has been about 100*l.*; and his is no solitary instance. Two crops a-year are grown, and the plan adopted is this:—when the crop from which the sets are selected in the autumn is lifted, care is taken to house the seed-sets, and when indications of sprouting begin, to encourage the growth of the germ in a healthy state by spreading them out in a dry place. The land being well prepared and highly manured, the sets are carefully planted in February, without rubbing off the sprouts; and this forms the early and principal crop, which is ready for market in June. From this crop a sufficient number of the smaller potatoes are reserved, and the land is again set with these as soon as the first crop is off, which produce the sets for the main crop of the succeeding year. The early crop usually realizes from 20*l.* to 30*l.* per acre, according to circumstances, and is

* The really warp soils of this Riding are not so extensive as are supposed. The great proportion is in the East Riding. Much error, I believe, exists as to the true origin of this soil: it is usually supposed to be the aluminous earth washed from the bottom, but it is now proved by the observations of Ehrenberg, and corroborated by English microscopists, to be the deposit of immense quantities of infusorial animalcules. In all rivers whose course is slow and deep, animalcules breed in immense myriads, and as both the salt and fresh water have each their distinct inhabitants, which cannot live in the other water, so on the flow of the tides, and the mingling of the salt water with the fresh, the animalcules of both are destroyed, and their bodies, with their siliceous coverings, deposited in such masses, as in many of the continental rivers to almost render the mouths of them unnavigable in a short time.

generally sold for the supply of Leeds. Carrots are occasionally grown in these districts, but being esteemed a more precarious crop than potatoes, and more troublesome to manage with equally satisfactory results, their cultivation is of course not so extensive. It must not, however, be inferred, that the bulk of the land forming this alluvial tract is of equal quality with that just alluded to. On the contrary, a very large proportion of it is strong and wet, and, from its low level, greatly dependent on the suitableness of the season for the yield of its crops.

As respects the cultivation throughout the range of the new red-sandstone it may, like the soil itself, be appropriately described as generally very good; without perhaps, at the same time, having any of those more marked peculiarities of culture which would seem to call for any special notice. The usual rotation on the lighter portions is the ordinary four-course turnip culture; the great facility which these sandy soils offer for the easy and rapid spread of twitch or couch grass, making the turnip crop every fourth year essential for the periodcal eradication of this weed. Where the soil possesses more stamina, as at Bawtry and Tadcaster, and more particularly around Whixley, Green Hammerton, and Boroughbridge, the longer rotation is practised. The barley from these latter districts is usually of particularly fine quality, in every respect, and is consequently much esteemed by the better class of maltsters, and realizes the highest market value.

From these productive soils we pass in succession to the poorer ones of the millstone grit, the culture of which presents no peculiarity, except that of being peculiarly bad. Fallow, wheat, and beans, is the customary mode of cropping, with occasionally oats, and here and there a few turnips, which are pulled and given to the cattle in the fold. I do not mean to say that some better cultivation is not found on these soils, but assuredly the exceptions are few. At Ripley, Otley, and one or two other localities, which come more immediately under the personal observation of some of the larger proprietors, better things are certainly met with. Nevertheless, there is a wide scope for some improvement in the cultivation of the inclosed lands and lower levels of this stratum; to say nothing of the more elevated parts, of the improvements to be effected upon which we shall speak in the proper place. Suffice it, that in many respects, and considering the disadvantage of climate they have to contend with, the management on these higher grounds is an example to their neighbours on the lower levels; and at least proves, beyond question, the capabilities of these altitudes to yield a compensating return for even that partial and superficial improvement to which they have been too long consigned.

The district called Craven, which, as I have before said, comprises the carboniferous or mountain limestone range, is almost exclusively in grass, the bulk being pasturage of a very superior kind, and the herbage possessing high feeding qualities. On the higher parts of the range are extensive grazings for young stock, which, from the character of the grass, a naturally drier soil than might be expected, and a consequently healthy atmosphere, thrive well. The breed of cattle is peculiar to the district, and is easily distinguishable by the long and wide-set horns. The sheep are also of a good size, with black faces and horns. In the more western part of the district, towards the Westmoreland boundary, the country presents such an irregular mass of rocks and mountains, that the valleys alone are accessible to cultivation, and are in fact barely sufficient for the wants of the inhabitants. A few flocks of scattered sheep pick up a scanty living on the mountain sides, reminding one of the trite reply of a Yorkshire moorland occupier to that eminent and zealous agriculturist Sir John Sinclair, who, when visiting some of these moorlands, amongst other questions, asked how many sheep to the acre they usually considered to be fair stocking? to which the answer was, "Why, mun, ye begin at wrang end first; ye should ax how mony acres to'l a sheep."

As respects the stock and breed of cattle generally throughout this Riding, it has been much less attended to than in either of the others. In the middle and eastern parts the horses are of a pretty good size, and in one or two localities which are favoured by circumstances, some better animals are bred. The districts around Doncaster, Wetherby, and Ripon, are those chiefly to be noticed for the production of horses, particularly hunters of good breeding and power. The draught horses which are usually employed both for agricultural and commercial purposes, are of mixed breeds; and not unfrequently selected without much regard to their appropriateness for the work. Those in the western parts are commonly small, yet active and hardy; but are of no distinct breed. Of horned cattle, the short-horns, and the Craven long-horns, are the only distinctive breeds:—the first in the middle and east parts of the Riding, and the other almost wholly confined to their native district in the west. There are, however, a great variety of cross breeds of a most incongruous character spread over the whole Riding. And when we consider the great numbers of Irish beast that have of late years found their way here, and how many of these have been domiciled and bred from, there cannot be much surprise at the mélange that exists. It has for some years too been the practice of the resident landowners, and the better class of farmers, to keep in their herds one or more Channel Island cows; and the fashion has also prevailed to

some extent amongst the wealthier manufacturers, who, having their residences in the suburbs of the towns, have deemed their domestic arrangements incomplete without an Alderney cow or two. The Riding possesses some few breeders of short-horns, whose stock is deserving of notice. Amongst these may be mentioned Earl Fitzwilliam, Mr. Wentworth, Mr. Fawkes, Mr. Cator, Mr. Stansfield, Lady Ramsden, and Mr. Crawshaw, of Byram. More attention of late years has been given to the breed of sheep, particularly in the turnip districts of the Riding, by the introduction of the Leicester, the improved Lincolnshire, and South Down breeds; and also by a breed, between the Leicester and Lincolnshire, from the Yorkshire wolds. A better description of Moorland breed has also been established. Perhaps the most prevailing system is to purchase the Border or Bamboroughshire ewes, or the Cheviot, and cross them with a good Leicester tup; sell the lambs fat to the butcher; take the clip; and fatten the ewes in the autumn. Where a *regular flock* of sheep is not kept, this plan is probably as good and profitable as can be pursued, the peculiarly good suckling properties of the ewes, and their aptitude to fatten, making both the lambs and themselves early fit for market. Many of the half and better bred Moorland sheep are annually fattened on the pastures of the lower lands, and from the general desire of the richer classes, both in the country and the towns, to procure this smaller description of mutton, they usually command a somewhat higher price per head to the butcher in proportion to their weight. The breed of pigs in the Riding is particularly good, both of the large and small kinds, many of the best breeders living within its limits. Some of the more celebrated of these are Dr. Hobson, of Leeds; Mr. John Hannam, of Deighton; Mr. Nutt, of York, and others. Very few, if any, of the black kind are bred.

Remembering how considerable a portion of the West Riding is within the influence of the several large towns, it will readily be conceived that the average size of holdings will be small. In their immediate vicinity the occupations seldom exceed from 10 to 50 acres; and throughout the manufacturing portion of the Riding generally, from 30 to 50 acres may be considered about the usual quantity in a hand. In the more agricultural parts, farms of from 300 to 500 acres are occasional, but more commonly they run from 100 to 200 acres, the majority however being from 80 to 100 acres. Notwithstanding the average annual value of the land of the Riding is computed at only about 17*s.* 7*d.* per acre, a great bulk realizes a much higher price. In the neighbourhood of the towns—although from circumstances the land is of late deteriorated—a rental of from 3*l.* to 5*l.* per acre is paid. And even in the rural districts, the better land fetches

from 25*s.* to 30*s.* per acre. Much of the strong and wet low land too realizes from 15*s.* to 20*s.* per acre, though very dear at that rent, in its present state. The Moorlands probably bring from 1*s.* 6*d.* to about 5*s.* per acre, according to the condition of the land. But even in these districts the dry and inclosed lands will let for from 18*s.* to 25*s.* per acre. Thus I esteem 17*s.* 7*d.* per acre rather an under average value.

*The improvements effected in the farming of the West Riding since the report of Mr. Robert Brown in the year* 1799, is the next head of our subject. And when we reflect that since the commencement of the present century the population of this important Riding has more than doubled, it certainly is neither an uninteresting or unprofitable matter for inquiry, in what proportionate ratio the cultivation of its soil has improved within the same period, in order to provide an adequate increase of supply for such an increase of consumers. Speaking of the farming of the West Riding at the time he wrote, Mr. Brown says, "1st. From Ripley to the western extremity of the Riding, nearly the whole of the good land is kept under the grazing system, and seldom or never ploughed; while corn is raised upon the inferior or moorish soils. During the time we were in that part of the country we hardly ever saw a plough, and a stack of corn was a great rarity. Upon the higher ground there are immense tracts of waste, which are generally common amongst the contiguous possessors, and pastured by them with cattle and sheep. 2nd. The land in the vicinity of manufacturing towns. The greatest part of the ground is there occupied by persons who do not consider farming as a business, but regard it only as a matter of convenience. The manufacturer has his inclosure, wherein he keeps milch-cows for the use of his family, and horses for carrying his goods to market and bringing back raw material. 3rd. The corn districts, or those parts of the Riding where tillage is principally attended to, and grass only considered as a means of bringing the corn husbandry to perfection. If we run an imaginary line from Ripley, southward by Leeds, Wakefield, and Barnsley to Rotherham, we may affirm that the greatest part eastward of it, till we come to the banks of the Ouse, which separates the West from the East Riding, is principally employed in raising corn. About Boroughbridge, Wetherby, Selby, &c., there is about one-half of the fields under the plough. Farther south, about Pontefract, Barnsley, and Rotherham, there are two-thirds; and to the eastward of Doncaster to Thorne and Snaith, three-fourths of the land are managed in a similar way. 4th. The common fields. These are scattered over the whole of the last division, but are most numerous in that part of the country to the eastward of the great North Road from Doncaster to Boroughbridge. It is

impossible even to guess at the quantity of land under this management. In general it may be said to be extensive. 5th. The Moors. These, besides the large tracts in the first division, lie in the western part of the Riding, and perhaps contain one-eighth part of the district. Upon them sheep are chiefly bred, and afterwards sold to the graziers in the lower part of the country." Mr. Brown further adds, "Betwixt Hatfield and Thorne there are great quantities of waste land, and much under water. Upon the whole, the land we have seen to-day stands in the greatest need of improvement, which cannot be done without a previous division." This was very true, and in due time these suggestions were carried into practice. This very district, by an Act in 1811 was inclosed, and an extent of something like 15,000 acres of excellent land brought into profitable cultivation. Since that period too, almost every other open common in the Riding has been inclosed, as well as most of the low waste lands, which at that time were very considerable. Attention has more recently been turned towards the inclosure of the moorlands, and especially in those districts where population has located and manufactures have been established. And, thanks to the general Inclosure Act, a few more years, and a few more mouths requiring to be filled, will conduce not only to the remaining lowland commons being divided, but to the inclosure of a very large proportion of the moorland districts. Every year adds some additional example.

Thus it is clear that, with this greater area under cultivation, the gross produce of the Riding must have materially increased, if only from this cause; but it is equally manifest that improved cultivation of much of the old inclosed lands has added very considerably to the general increase of production; and it is not, I think, any exaggeration to estimate the average increase of wheat per acre on these lands at from 8 to 10 bushels, since the period of Mr. Brown's report. Taking the total area of the Riding, as already stated, at 1,648,640 statute acres, it is probable that something like the following apportionment will, in round numbers, approximate sufficiently near to the actual quantities under the respective heads, viz.:—

| | Acres. |
|---|---|
| Grass land . . . . . . . . . | 720,000 |
| Arable land . . . . . . . | 680,000 |
| Moor and waste land . . . | 200,000 |
| Woods and commons . . . | 48,640 |
| | 1,648,640 |

Of these 680,000 acres of arable, it will, perhaps, be within the mark to affirm that 100,000 have been brought into cultivation since 1799. If then we compute the produce of wheat at that

period, on an area of one-third of the 580,000 acres then under the plough, at an average yield of 22 bushels per acre, we shall get a total produce of about 4,250,000 bushels per annum; against a produce now, computed in the same manner, with an average of 30 bushels per acre, of about 6,800,000 bushels. When, however, we take into account that wheat is now being grown upon the lighter lands, many of which at the earlier periods of cultivation were not considered capable of growing it at all, we may fairly estimate the increased produce of wheat now at two-thirds more than at the commencement of the present century. The increase too in the other corn crops will bear a proportionate ratio, or even perhaps somewhat exceeding this. There is also a considerable increase of animal food, consequent upon improved cultivation; but I do not think that it is to a proportionate amount, or that it at all bears such an adequate ratio to the improved culture as it ought to do.

It was not until the cessation of hostilities, and after peace was fully established, that men began to turn their attention to those domestic improvements which had so long slumbered under the accumulation of more pressing demands upon their time and exertions for the supply of the immediate wants for home and active foreign service, which the great drafts of the more able-bodied for our troops had imposed with greater necessity upon civilians at home. It was not, I say, until all this had passed, that men looked to see what improvement was needed at their own doors; and true as this was of all classes in general, it was, I believe, more especially so with respect to the cultivators of the soil. The high price of produce at that day was practically no incentive to agricultural improvement; nor was it until, year after year, prices gradually re-adjusted themselves to peace rates, that the agricultural interest, as a body, became sensible that continued profits from the land were to be obtained by the additional produce of an improved and more economical cultivation, at a lower scale of prices. And our daily increasing population from that time has shown *that* to be the only just and proper course. If then the experience of the past 30 years has demonstrated the sound policy of cultivation keeping something like a proportionate pace with the increase of consumers, even when that increase was but, as it were, in its infancy; how much more imperative must it be in these days of its maturer strength, when in the solution of this horseshoe-nail problem, we are fast approaching the incalculable numbers?

The improvement in cultivation which has been effected within the period under review has not been brought about by the *exclusive* exertions of the practical cultivators of the soil. Many of the most valuable implements we now possess, and suggestions

of the greatest benefit, have emanated from men whose knowledge of the mere practical routine of farming operations has been comparatively limited; but who, nevertheless, from observation and subsequent experiments, have been enabled to throw much true light on the subject generally, and to perfect many of the very best appliances which the agriculturist of this day possesses. Although it may be said to be but of recent date that any very marked advance has been made in the application of mechanical means to the general purposes of agriculture, yet unquestionably the gradual development of these means has tended very materially towards the improved culture, by affording a more suitable class of implements, and consequently securing greater economy in the preparation of the land, as well as in many of the subsequent operations. In a district, indeed, like the West Riding, where so much mechanical skill proverbially exists, it is a matter of some surprise that its application has not been earlier directed to the requirements of agriculture. No sooner, however, did the stimulating influence of the Yorkshire Agricultural Society's annual exhibition come into action, than a host of mechanical competitors entered the field, and with them an equally numerous selection of implements, that have ever since been increasing both in numbers and effectiveness. The improved plough, the scarifier and grubber, the drill, the turnip and straw-cutter, and the improved roller, were amongst the earliest productions; whilst the more recent exhibitions have brought out the portable and fixed steam-engine, with its improved threshing-machines, the corn and seed-mills, and the tile and pipe-making machines. And since the increase of these latter may be taken as a fair index of the progress which the essential operation of draining has made within the few past years, not only in this Riding, but throughout the county, it may not be uninteresting briefly to revert to their first appearance. I believe I am correct in saying that no tile-machine was exhibited at the Yorkshire Society until the meeting at Richmond, in August, 1844; at which period it is equally true to say, that no such thing as a machine-made tile or draining-pipe was to be found in the North of England. Such, however, was the stimulus created at Richmond, that, to my knowledge, one engineering firm alone in the West Riding has, since April, 1845, made no less than 130 tile-machines, about one-third of which are working in the county of York. If, then, within the short space of three years such a change for the better—not only as regards the economy, but as affecting also the efficiency of the operation—has been secured, what may we not hope to attain now that the mechanical energy and talent of the district have been thus successfully aroused?

We have now arrived at the last, and certainly not the least,

important division of our subject, viz., *the improvements still required in the Riding generally.*

Few, I think, who have marked the progress which has already been made, and the earnest desire for further knowledge now existing amongst all classes connected with agriculture, but must feel assured that a great and important change in the general economy of cultivation is gradually but surely being established; in fact, that the agriculture of this country is undergoing that state of transition from which its manufactures have but so recently emerged; and since the most sceptical have never yet ventured to assign a limit to the productiveness of the soil, there seems no reason to fear but that the result of such a change will be beneficial to all classes of the community. Take for example the growth of wheat, and we shall find, in almost every township, and over districts where the general character of the soil is the same, a *maximum* yield of 50 or 60 bushels, and a *minimum* one of 20 bushels, per statute acre. One occupier—of more capital, and possibly more intelligence than the others—has an average produce from his wheat-crops of 40 bushels per acre (and I last autumn saw more than one farm in this Riding which would fully realize this), whilst his neighbour, farming the same description of land, and only having to look over the hedge to see what is done and its results, cannot succeed in obtaining above 30 bushels. Why should this be so? For it is obvious, that if 40 bushels per acre can be grown by one person, they can by another, adopting a similar course of management on a similar soil.

But it may be the one land is drier than the other—the one drained, the other not;—and in by far too large a proportion of instances this really is the discouraging position in which the grower of the 30 bushels per acre finds himself. He sees his neighbour, who probably, at the most, does not pay above 10*s.* per acre more rent than himself, securing, with a less amount of labour and horse-power in the preparation of his land, a greater produce by at least 50*s.* per acre in value. Why then, will be asked, does he not drain his land? To which he truly and justly answers, "I am the occupier only, and my capital and time are both fully required for the *cultivation* of this land; not for improving the owner's fee-simple in perpetuity. I have not the least objection to pay any reasonable per centage on the outlay, in additional rent, which my landlord may require, even to the extent of 10 per cent., rather than remain as I am; but I cannot undertake to drain the land myself, because in so doing my other operations on the farm would be disarranged by reason of the necessary additional outlay, although I know that probably the extra produce from the two next succeeding crops would reimburse me," Hence the necessity and the justice of pro-

prietors undertaking drainage works themselves, and charging such an additional rent as shall pay a compensating interest on all the cost.

Over the great proportion of the land on the coal-measures, the alluvial, the millstone grit, and some of the new red sandstone formation, the first step to a higher state of culture requires yet to be taken—that of *a systematic and effective course of permanent drainage;* and until this is done it will be folly in the generality of the occupiers of those lands making any great effort at a higher course of cultivation. In those instances where the drainage has been *thoroughly* and properly done, it has proved to every observer that the lands of the coal and millstone-grit possess, when suitably dry, productive powers of the highest order. We may instance much of the strong soil on Mr. Wentworth's estate at Woolley, where turnips are now being grown and eaten on, upon land that but very recently produced nothing beyond precarious crops of wheat and beans. And again, the still stronger and poorer land of Mr. Paley, at Harrowgate, which but a few years ago was sufficient during one-half of the year to produce an ague-fit, and the other half resembled a demi-burnt brick, and is now growing abundant crops of turnips, wheat, clover, and wheat. It is curious, too, to observe on this land the vigorous and renewed growth of the hedges and young trees, which has manifested itself since the drainage has been done, and is the more palpable from the evidently water-logged appearance they previously exhibited.

There is a great deal, too, of what is usually esteemed dry land that would be much improved by a *judicious* course of drainage; and there is still more of it that would be benefited by the application of the subsoil-plough. I have no doubt, when Mr. C. Charnock commenced subsoiling and trench-ploughing the limestone land of his Holmfield farm, he was laughed at, and condemned for so absurd and apparently useless an expenditure; but the practical result has shown that he exercised, from observation, sound reasoning on the effects the operation would produce; while they who laughed had not. Last autumn, when inspecting some drainage in the North Riding, I observed, from a considerable distance, that one side of a large field presented a very much browner appearance than the other—so much so, indeed, as to make me at first think it had been ploughed out. On coming nearer, however, I saw this was not the case; and knowing that the subsoil changed very abruptly in the middle of the field, from a dry porous marl to a strong retentive clay, the cause of the brown appearance was soon manifest. *That* side was the wet clay portion of the field, and which I had previously seen saturated with water; the other was the dry side on the marl, the

herbage upon which contrasted so favourably. The excessive drought had so contracted the clay, that the sun and heat were admitted freely into it in all directions and to a great depth, literally destroying vegetation by this process of baking; but on the marl, which from its naturally dry and friable character admitted of little or no contraction, the sun's rays and heat did not penetrate much beyond the surface, which every night was in a condition to imbibe its proportion of dew; whilst on the hard-dried portion of the field it fell as ineffectually as "water on a duck's back." Hence that increase of production which Mr. Charnock mentions as the result of his subsoiling, even on the dry land. It is *always* ready to imbibe and reap the fullest benefit from whatever moisture falls upon it; and at the same time *never* liable to that excessive injury from drought of which we have just spoken.

After effective drainage has put the land into a condition to be cultivated systematically and economically, the next consideration should be the adoption of such a rotation as shall ensure an ample supply of green crops for a much greater number of stock per acre than is now kept; this will soon conduce to a higher state of cultivation of the land, and at the same time benefit the community at large. I hold, too, that—with perhaps an occasional exception—bare summer-fallows should be wholly abolished in good farming. The annual waste of manures of various kinds, for want of proper conservation and appliances, is much to be lamented; and more especially so in those rural parts of the Riding which have not the advantage of being within reach of a large town. I would recommend to every farmer and proprietor an attentive perusal of a paper entitled "*The Economy of Waste Manures*," published in the *Transactions of the Yorkshire Agricultural Society* of 1843, written by Mr. John Hannam, who is himself an extensive practical farmer, and has given abundant proof that what he writes may be practically relied upon. This paper embraces so completely and intelligibly the entire subject of manures in their application and conservation, that if by this appeal I should conduce to its being more generally read and attended to, I shall be assured that one object at least has been attained with more promise of good results than by anything further I could say here.

There is, however, one portion of the general subject of manures which, under the peculiarly favourable circumstances which many localities in this Riding offer for its effective and cheap adoption, must not be suffered to pass without a brief consideration: I allude to *the mechanical application of the sewage and refuse of our large towns to the purposes of agriculture and horticulture.* So much has been of late said and written upon this subject, that but for the *facilities of application* which the *West*

*Riding of Yorkshire more especially presents,* a passing notice might have been all that was called for in this place. Having these facilities, however, and knowing, as many of us do, not only the mechanical means required for the application of the refuse, but its great benefit when applied, and the low cost at which by this mode an acre of land can be manured, it seems to deserve some further attention. The reader may have noticed that Mr. W. Holt, in his account of his land at Horbury, having grown wheat in succession many years, says, "I have not given this land any manure for 25 years, except about 4 dozen of lime and a few ashes, and it has averaged 13 or 14 loads of wheat, or 39 and 42 imperial bushels per acre." Now this land adjoins the river Calder, the floods from which have proved a sufficient manuring to maintain its full fertility and yet grow successive crops of wheat year after year; and this field is by no means a solitary instance of the richness of this and many others of the West Riding valleys that are watered by its rivers, the fact being that wheat is not so much grown in them because, from their fertility, more straw than corn is produced; and it would be so with this land at Horbury, were it not "let down" by a continued succession of the same crop. Whence, then, is this richness? Unquestionably from the numerous blue, red, white, and black tributaries that flow from all sides, and from all the manufacturing towns on its banks, into the main water, which by floods is in its turn distributed over the adjoining lands. Notwithstanding a host of such facts that might be adduced, a "discerning public" arrive at conviction by a slow, but not less sure, process. They do not at once come to the conclusion that it is as practicable, by mechanical means, to convey the sewage-water *out* of our towns, as it is to convey the clean water *into* them, nothwithstanding that the latter is daily practised. The same tardy conviction was manifested in the practicability of several other mechanical means that are now universally adopted—gasworks, railways, and waterworks attest this. The West Riding, however, seems to be alive to the benefits which the adoption of sewage application would confer; and I believe that no less than four plans and notices were, in accordance with the standing orders, deposited last November with the Clerk of the Peace, viz., from Leeds, Halifax, Sheffield, and Wakefield. Thus imaginary difficulties seem to be vanishing before the tangible facts of every-day experience, and the practical knowledge of Yorkshire mechanics and engineers, who, I doubt not, will verify Warren's definition of *difficulty*—"only a word indicating the degree of strength requisite for accomplishing particular objects; a notice of the necessity for exertion: a bugbear to children and fools; only a mere stimulus to men."

With reference to the reclamation of the waste-lands of the Riding, it has already been noticed that on those of the millstone-grit formation abundant evidence exists, in the productiveness of those inclosures that have already been subjected to cultivation, of what a large extent which is yet unreclaimed, is capable. I know many instances where tracts of this higher land are to be seen growing nothing but heather, and not realizing more than about 1*s*. 6*d*. per acre (shooting included), whilst *immediately adjoining*, on the same level, are cultivated plots that let for 20*s*., 25*s*., and up to 30*s*. per acre, and produce excellent crops. As I have already said, there is no very great proportion of peat on these lands in the West Riding, and consequently their reclamation would be the sooner accomplished. After the drainage work is completed, which is the first thing to be done, probably the best plan of proceeding is to plough the land, turning down as much of the ling as possible (without paring and burning it, as is too often practised), lime it, and sow it with rapes, and eat them on with what sheep you can get; after which, plough it and prepare it as thoroughly as possible, burning, if you like, at this stage any stalks of ling that may come to the surface, and plant it with potatoes; after this, with a further liming (for it is generally deficient in this mineral), sow it with oats or wheat, as you may find suitable, and clover or seeds to be eaten on. There is nothing expensive in this mode of proceeding, and the potato-crop will in most instances fully repay all the previous outlay; nay, even occasionally, including a considerable proportion of the cost of drainage.

No doubt, for a time, you have an inferior climate to contend with; but were it possible at once to drain the whole of these districts, this objection would in a very manifest degree disappear. The badness of the climate arises from an excess of exhalation, consequent upon an excessive surcharge of water in the land. The fact of the climate being made good by drainage has been often exemplified in the low lands, in the fens for instance, where ague—once so prevalent—is now never heard of; and many instances of the same effect might be given in more limited localities. I heard an intelligent farmer state that, since he entered on his occupation, the whole has been thoroughly drained; that on his first coming he found most of his neighbours' crops, on the higher ground around him, reached maturity a full fortnight before those on his farm; but that since the drainage has been completed, his crops are invariably a week or two earlier than the immediate district. I refer to Mr. Moor, of Ackworth, near Pontefract, whose farming is an example to that locality.

After taking a course or two of corn-crops from the reclaimed

land of these moor districts, so as to bring it into a proper tilth, and to completely eradicate the heather, it would, if *well laid down* with *a proper selection* of permanent grasses, make good pasturage for young stock; and, probably, with a little attention, in a few years become really good grass-land, and capable of carrying a considerable number of both beast and sheep.

If, in alluding to the condition of the agricultural labourer of the West Riding, we say that there is, perhaps, no district in the kingdom in which he is better paid, better housed, and better cared for, it would only be doing common justice both to him and his employers; but I believe, if we go one step further, and say that he is in many respects better off, and more completely independent than they are, the truth will not have been exceeded. The general wages of the common labourers are from 14*s.* to 16*s.* per week; and in those occupations requiring somewhat more of judgment and skill in manipulation—in drainage, for instance—they expect to earn 18*s.* per week, and upwards. In the cheapness and excellency of fuel throughout almost the whole Riding they possess a very great additional comfort and advantage over those of their class in many of the more southern counties; and which certainly fully compensates for the higher house-rents which they pay in the North. The women and the older children generally obtain as much employment, both on the farms and in other ways, as they can spare time from their domestic occupations to attend to. Their wages are usually from 8*d.* to 1*s.* per day, most commonly the latter. From the number of applications from this Riding, and from the county generally, for advances under the drainage Acts, there is every probability of the able-bodied, who are capable of such work, being fully employed for some years to come. And it is not only these drainage-works, but many other proprietors are draining extensively; and all who desire to let their land or retain good tenants, must do the same; for the time is at hand when the first question asked by those about to occupy strong land will be, "Is it thoroughly drained?"

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XV.—*On Climate in Connection with Husbandry, with reference to a work entitled "Cours d'Agriculture,* par le Comte de Gasparin, Pair de France (Membre de la Société Générale d'Agriculture, de l'Académie des Sciences, &c.). 3 vols. 8vo. Paris. 1846." By the Earl of LOVELACE.

MONS. GASPARIN'S work, the substance of which had previously been communicated through the medium of lectures before an audience of French proprietors who had gone through a course of university studies, appeared for the first time in a complete form in 1844. The author had been long and favourably known

to his countrymen as a man of science, an accurate observer, and a practical agriculturist; a combination so rarely met with as to render the results of his studies on a subject which had been the main occupation of his life more than usually interesting.

With one remarkable exception (the breeding of stock,* which he does not consider as necessarily connected with the profession of the husbandman) the range he treats of is very comprehensive, embracing the various questions of the limits, economical, statistical, agricultural (properly so called), and the meteorological, or those depending on climate. The first imply an examination of the mean amount of produce, the price it will command, and the necessary expenses of cultivation.

The second regards the adequacy of the indigenous population to gather in the harvest of the crops which it raises, and which cannot be omitted from the consideration of the agricultural capabilities of a country. In large cultivation on an extended scale the resident ordinary labourers are insufficient: in the north of France, where there are still some large farms, troops of Belgians come in to secure the harvest. In the south the mountaineers, while their own crops are ripening, go down to reap the earlier ones of their neighbours in the plains; it is the same in great part of Italy; and there is a similar migration of the Irish into England, and of the highlanders from the Oberland in Switzerland. The French harvest requires 2 men and 2 women for every $2\frac{1}{2}$ acres, while the usual proportion of hands to the corn land near Paris is one labourer to every 59 acres. So that the state of the population may forbid certain cultures. Vines if cultivated by hand require, as do hops with us, very great and constant attendance. Yet in some parts of Languedoc, where the plough is substituted for manual labour in the vineyards, they require no greater number of labourers than the ordinary tillage land, except during the vintage.

Much again will depend on the tenure; for if the occupier has no certainty of remuneration by means of a sufficient term, he will necessarily grow only the crops which bring him in an immediate return.

Lastly comes the question of meteorological influences; the action of heat and cold, humidity, drought, and light—all those circumstances and elements whose combinations produce what we call climate.

The book is illustrated with a map of the western part of the

* In justification of M. Gasparin's omission, it may be observed that in this country the breeding and rearing of horses, particularly of those for the turf, is quite distinct from agriculture: that of poultry tends to become so. The great feeders of cattle in the south seldom rear them; and the flockmaster of Wilts and Hants is mostly distinct from the party who supplies the butcher.

continent of Europe, on which M. Gasparin has coloured what he conceives to be the regions proper to the successful cultivation of certain crops, forming the chief distinguishing features of European husbandry; and which our countryman, Arthur Young, had been the first to indicate sixty years ago. Thus, Spain, the Mediterranean coasts of France and Italy, Dalmatia, and Istria, are marked as proper to the olive, of which he considers the north of Africa to be the native habitat.—This requires two prominent conditions: one, that the winter should not on an average be more rigorous than 17·6° Fahr.; the other, that the summer should be sufficient to permit the tree to ripen its fruit. The heat is so great, that although corn is generally grown throughout these countries, and ripens early in the season or before Midsummer, yet the "*culture arbustive*" is always the chief resource. The climate imposes this law on the inhabitants. For though the grains are of good quality, the drought is so great, the hardness of the earth comes on so early, that the roots of annuals are unable to make their way down so as to extract the requisite nutriment; those of the shrubby plants and trees—olives, vines, figs, mulberries, currants, oranges, and almonds, whose alimentary canals penetrate deeper, enable them to thrive better than plants deriving their sustenance comparatively from the surface. Indeed, M. Gasparin imagines that the olive will, thanks to a more intelligent management, at some future time take the place throughout the south of Europe of all other oleaginous, but herbaceous plants.

The next grand division is that of the vines, which, besides being common to all the preceding districts, occupy in addition a zone extending in an E.N.E. direction from the mouth of the Loire to the north of Dresden. Within portions of this tract the summers are still hot enough to ripen maize. For to neither of these crops is the severity of the winter season of any consequence; but a due amount of summer temperature is indispensable. The dryness of the summer and the cold of the winter are unfavourable to pasturage, and to some extent consequently to the production of stock; it is only in those mountainous districts which emerge into another climate from the midst of this tract that it becomes a branch of industry.

Northward of this comes the cereal territory—so named by M. Gasparin on account of its peculiar, though not exclusive aptitude for growing corn. He leaves out, as not hot enough, part of the north-western coasts of France; all Holland; parts of Westphalia and Norway—so that the corn-growing zone would form a narrow strip between the vine-growing lands on its S.S.E. border, and the pastures and forests on its N.N.W.; and here arises a question interesting to us as Englishmen.

"Are the British Islands (asks M. Gasparin) quite out of this category? Without the high price at which their legislation maintains corn,* would not the breeding and rearing of cattle be their most productive employment, as it is in Ireland and the highlands of Scotland? It is a question which we should be tempted to answer affirmatively."

However, M. Gasparin's map, while it abandons all Scotland and Ireland to the pasture and forest zone, together with Norway, Holland, Denmark, and Sweden, reserves the eastern half of England proper among the countries producing corn.†

Although M. Gasparin's possessions and practice connected him with the region of the olive, for he had long observed and occupied himself with the industry he has been describing at Orange, in the valley of the Rhone, not far from Avignon, yet the cereal band is what he terms the classic land of rotations, where forage and green crops may be made to alternate with corn.

We are apt to imagine that the uncertainties of the British climate are greater than those attaching to other parts of Europe, and that they interfere more seriously with the enterprise of the husbandman, and impede the successful pursuit of his profession to a greater degree than the more favoured regions of the south, which we fancy to be exempt from those disappointing vicissitudes that cloud our northern skies. We gather an opposite inference from the perusal of M. Gasparin's lectures; all the regularity of rotation and steadiness of routine, in his opinion, belong to the northern agriculture—the doubts and risks attach on the contrary to those of the hotter south. In the first the farmer may translate the lessons of experience into ready-made rules of easy exemplification. Every year he may go on doing that which he did the season before; but these methods will not apply to the southern districts of Europe, which appear to pay dearly at times for their more continual sunshine.

"The intelligence of the agriculturist must be constantly on the alert to repair the damages occasioned by the extremes of heat or wet;‡ there where he thought to sow pulse he must raise additional forage, because the drought has withered up those resources on which he de-

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* This was written before the repeal of the corn laws.

† Mr. Williams of Pitmaston, in his Essay on Climate, published more than forty years ago, observed, wheat was averse to the humid climates. He then thought the moisture of our summers was so much on the increase, that eventually England, from that cause alone, might cease to grow wheat.

‡ There is no doubt that a dry climate greatly improves the quality of wheat, as increasing the quantity of that gluten on which the real value of the flour so much depends. No finer bread can be eaten throughout Europe than is made in the Castilles—a central portion of Spain—from wheat grown in that region of open land, where rain seldom falls during the entire summer.—F. Burke.

pended for feeding his cattle. Sometimes the over-abundance of hay will permit him to increase their numbers, at other times he must hasten to get rid of them, because his grass-crops have failed. Some seasons he will have an ample supply of manures, in others he will be short of them; one year he must hold back his wheat, because a plentiful harvest will have reduced its price; the next, the drought in the spring will have produced a scarcity, and he must plough up his pastures in order to supply grain for his family; a set rule would be his ruin; nothing but an irregularity in accordance with that of nature and the seasons will save him from losses."

But in the region of the cereals, extremes and accidents are rare.

"From the spring being so much later, we reach the summer solstice when the season is most regular, the weather the most settled of the whole year, just at the moment when all vegetation is most fully developing itself.

"The necessary complement of labourers, stock, and capital can be determined upon beforehand. The produce is in proportion to the consumption, and all irregularity of culture is punished, because it finds no compensation in any corresponding irregularity of season. It has produced that steady rotation of crops according to formulas which please the mind by their continual recurrence and their almost certain returns; it is an agriculture from which other regions may usefully borrow partial information, but which cannot, as a whole, be transplanted elsewhere. In the hotter and more uncertain climates, far greater firmness and forethought are required on the part of the tenant to reimburse himself by good returns for the deficiency of his bad ones, so that he may not be alarmed at the frequent or certain recurrence of the last. He must have more than all these, he must have a capital sufficient to withstand the reverses which may happen at the beginning of his lease. These contingencies, which render farming conditions so difficult in the districts of the olives and the vines, scarcely exist in the corn cultivation, and not at all in the pastoral countries—the most ordinary understanding is there competent to carry on a farm."*

Cider and beer there take the place of wine; the land opened in the spring can be ploughed throughout the summer.

"This regular order of the climate, and of the operations of agriculture, react favourably on the populations so employed; they are the most peaceable, moral, and well-instructed in Europe."

These observations show that if each great division of the earth's surface has received what appear at first sight to be peculiar advantages, they are for the most part modified by such circumstances as re-establish something like an equality of condition

* It is so in the British islands generally; the dairy farmer is lowest in the scale of enterprise, while the hop cultivation, which is subject to greater contingencies, and gives perhaps in a good year the highest returns, requires also the greatest capital, skill, and experience.

with our own. Even within the cereal zone,—i. e. that which enjoys greater stability of seasons than those of the vine and olive lands—there are greater vicissitudes of heat and moisture than in England. Take for instance the occurrence of hoar-frosts, so destructive in their effects on our early garden produce in the spring. The mean number of these at Orange is 17·7, while at Rome, where they have been known to occur in June, it is 63·8. The buds of vines and mulberries are destroyed by them as frequently as our peach blossoms in England. In Italy, a district round Otranto is ironically called the Land of Flowers, since the recurrence of these visitations so often prevents their being succeeded by fruit. When the average returns of these phenomena are known for any particular locality, the probable loss its crops may sustain from that cause may be calculated. Acting upon these acquired data, and finding that at Orange, in the 17 years between 1813 and 1830, there have been 4 white frosts at the end of April or the beginning of May after the leaves of the mulberry had appeared, M. Gasparin infers that this is a liability which may be apprehended once in 5 years; and further, since experience shows that its occurrence causes a loss of one-fourth of the crop, the whole risk (1-5th of the time × 1-4th of the crop) is equivalent to an annual diminution of 1-20th.

This takes place in the plain of Orange, lying in the centre of the great valley of the Rhone, and which is rather favourably situated; other localities, not very distant, are far worse off, as at Lavaur, where it occurs every three years.

The effects, indeed, of cold on vegetation must be considered under three different heads: first, its intensity; second, its duration; third, the period of its occurrence. It is this last unseasonable condition which renders a small descent below the freezing point in the spring so pernicious to the vegetation, which is then full of sap in movement. The decrease of temperature at this season is owing mainly to the radiation from earth into space. Wherever the atmosphere is habitually clear, the maximum of temperature differs more from the minimum than in those which are habitually clouded. The clear sky favours the nocturnal radiation of that heat from the earth, which, owing to the same cause, the sun has imparted to it in the course of a bright day.

The distribution of caloric all over the globe is far from being governed by the parallels of latitude. The degree of cold in the winter will be mainly affected by the humidity or dryness of the atmosphere. The oceanic or insular climate, more or less common to the whole of the British islands, but particularly to be remarked on their western coasts, condensing the humid vapours that have swept over the Atlantic, tends to modify the heat of summer, and to diminish the cold in winter. Lines of isothermal

temperature may conduce to the production of very different climates.*

The annual mean temperature of two different places may be 50°; in the one case it may result from a summer mean of 62°, and a winter one of 38°; in the other the summer season may be 70°, and the winter may be 30°. Yet in the first of these, which is nearly that of the south of England, while corn would ripen well, the myrtle could exist. In the second, vines and even maize would succeed, while the severity of the winter would entirely forbid many of those plants, such as ilexes, arbutus, and bays, which in our northerly islands so agreeably recall the associations of the warmer south.

In fact, it is the average temperature of each season rather than of the whole year which is of importance in regulating the agriculture of a country.

The north of Germany exceeds a little the latitude of Lincolnshire; and, notwithstanding the rigour of its winter, so considerable and certain is the amount of caloric it receives between May and August that its harvests are earlier and surer than with us. The snow covers the ground for above a quarter of the year, yet the intensity of the cold by no means interferes with the grain-producing aptitude of the soil, though it necessarily drives into a narrow compass all the operations of the husbandman. On the other hand, it would seem to interpose an obstacle to the rapid multiplication of cattle, since even the better breeds of sheep, not to speak of the heavier descriptions of stock, require to be housed and fed with roots and forage artificially provided during so large a portion of the year. The outlay, therefore, in buildings, no

* The following are from Mahlmann's tables, originally published in Humboldt's Climatological Researches, but since printed in Kæmptz' Meteorology, translated by Ch. Walker:—

| Latitude. | Place. | Mean Temperature. | Mean Summer Temperature. | Mean Winter Temperature. | No. of Years' Observations. |
|---|---|---|---|---|---|
| ° | | ° | ° | ° | |
| 51·31 | London . | 50·72 | 62·78 | 39·56 | 40 |
| 48·50 | Paris . . | 51·44 | 64·58 | 37·94 | 33 |
| 50·70 | Penzance . | 51·98 | 61·70 | 43·88 | 21 |
| 48·19 | Munich . | 48·02 | 63·32 | 31·28 | 32 |
| 48·23 | Vienna . | 50·18 | 68·24 | 32·36 | 24 |
| 39·54 | Pekin . . | 54·86 | 82·58 | 26·24 | 6 |

The annual mean of the five first of these places is not very dissimilar; yet it is obvious at a glance that there can be few characters common to their respective vegetations, subject to such extremely different conditions. The summer heat of Pekin exceeds that of Bombay, Batavia, or Trincomalee; the cold of the winter surpasses that of Stockholm, or Tilsit, or Cracow.

matter how rude, to procure the necessary shelter, and their annual maintenance, would militate against any rapid expansion of this branch of agricultural enterprise in Germany. While in the British islands stock of all kinds, save when fatting, lambing, or in milk, may be said to endure the ordinary vicissitudes of our seasons without inconvenience.

These extremes are not limited to Germany, or what is called the north of Europe. France, Piedmont, and Lombardy experience, though for a shorter time than England, over large portions of their superficies, degrees of cold equal to that which has been noted on this side the Channel. Their winter is brighter and drier than ours, and so far more favourable in some respects to vegetation, and, with particular constitutions, it may be, to bodily health. Their days are longer, between the autumnal and the vernal equinoxes, than ours; but, away from the sea-coasts and out of the reach of the modifying influence of the maritime air, far greater deviations from the mean, both of heat in summer * and of cold in winter, are to be met and provided for.

The average temperature, however, of each season, as measured by the thermometer, does not appear to be the only condition which determines the growth and maturity of vegetation.

M. Gasparin endeavours ingeniously, but not with perfect success, to substantiate and define the theory propounded by his countryman, M. Boussingault, with regard to the quantum of caloric required by certain plants to arrive at maturity. Boussingault's position is that wheat requires 2000 degrees of atmospheric heat (*chaleur moyenne*), Centigrade, from the time when it resumes its growth in the spring until it is fit for the sickle. It is not, at first sight, easy to translate this measure of caloric into such a description as will render it intelligible at a glance to the English reader, who is accustomed to the Fahrenheit scale. It appears, however, to import in substance, that the mean temperature of the period or periods elapsing between the first movement of the sap in spring and the ripening of its grain, when multiplied into the number of days, should present such an amount of heat as to equal 2000 degrees of the Centigrade; so that, supposing four months to intervene, it would require that the average temperature (solar and atmospheric) of each day should be 16·7°

* At Paris the average number of frosts, according to M. Chr. Martins, is 56; in the winter of 1812 there were 91; in that of 1838, 74; in 1840 as many. The greatest cold of late years was on the 20th of January, 1838, when the thermometer sunk to 2·2° below zero, Fahrenheit. In the department of the Ain it was more severe, going down to 13° below zero, Fahr.: all the mulberries were killed. Even at Orange, in 1820, the mercury marked 8·6° Fahr. on the 11th of January; on the 15th a sudden thaw occurred, which was fatal to the olives in Provence. In the years 1745, 1748, 1766, and 1802, with a frost of 6·8° Fahrenheit, no ill results followed, where the trees had the benefit of a free current of air.

Centigrade, which, multiplied by 120 days, would give 2004°. This would correspond to a daily heat of 62·06° Fahrenheit. Both Boussingault and Gasparin conclude that the range marked by the thermometer in the open air is insufficient to produce an amount of caloric accordant with what they deem requisite for the maturity of the crop. They adopt, therefore, a supplement of solar heat, distinct from, and in addition to, the observed temperature of the air. But this latter element does not seem to have been so accurately calculated or so clearly defined by them as to enable its truth as a rule to be tested by its application to other countries and climates. Although the subject is treated at some length, the tables appended do not distinctly give the mean atmospheric temperature for each month, together with the ascertained amount of solar heat, and the additions to be made on that account. Nor do the tables appear perfectly consistent either with each other, or with the calculations based upon them.

Assuming, however, that wheat begins to vegetate afresh when the medium temperature of the spring advances to 42·8° Fahr., M. Gasparin tells us that that point is reached at Orange on the 1st of March, and at Paris on the 20th; and that the harvest takes place ordinarily at Orange on the 25th of July, and at Paris on the 1st of August; that is, respectively in 117 and 132 days' growth. According to M. Gasparin, the plant has received in that interval the following quantities of caloric:—

| | At PARIS. | | | | At ORANGE. | | |
|---|---|---|---|---|---|---|---|
| | Centigrade. | | Fahr. | | Centigrade. | | Fahr. |
| — | Monthly Mean Solar and Atmosph. | Total. | Monthly Mean. | — | Monthly Mean Solar and Atmosph. | Total. | Monthly Mean. |
| | ° | ° | ° | | ° | ° | ° |
| March (10 days) | 10·9 | 109 | 51·62 | March (31 days) | 16·7 | 517·7 | 62·06 |
| April (30 do.) | 15·8 | 474 | 60·44 | April (30 do) | 19·3 | 579 | 66·74 |
| May (31 do.) | 18·7 | 579·7 | 65·66 | May (31 do.) | 22·3 | 691·3 | 72·14 |
| June (30 do.) | 19·3 | 579 | 66·74 | June (25 do.) | 27·2 | 680 | 80·96 |
| July (31 do.) | 22·3 | 691 | 72·14 | | | | |
| | | 2,432·7 | | | | 2,468 | |

Although this table (which is extracted from vol. ii. p. 87) does not bear on the face of it any discrepancy, yet it is impossible to arrive at the results it presents by merely adopting the data as given at pp. 77, 78, on which it professes to rest. M. Gasparin there gives certain monthly maxima and minima of atmospheric temperatures observed at Paris, Peissenberg, and Orange, as well as augmentation due to solar heat alone, but un-

accompanied by any intimation of the method by which he arrives at the results which appear above. By combining, however, the maximum monthly temperature given in one table with the minimum given in another, an atmospheric mean is obtained, different indeed from any presented by him. There remains the solar heat proper, of which the amounts respectively due to each month are stated. At first sight, it would appear intended that they should be added as they stand to the atmospheric range, in order to complete the quantities of caloric due to each source, but this operation gives far too high a figure; at last, it occurred to the writer of this paper to divide the amount of solar heat, and strike out one-half, which might be considered as neutralized by the night. The following table shows the application of the calculation to Paris:—

| | 1. | 2. | 3. | 4. | 5. | 6. |
|---|---|---|---|---|---|---|
| —— | Mean highest Monthly Temperature, from p. 77. | Mean lowest Monthly Temperature, from p. 78. | Mean, Monthly Temperature, deduced from the two preceding. | Additional Solar Heat, from p. 77. | Half the Solar Heat. | Mean of Solar and Atmospheric, by adding Cols. 3 and 5. |
| | ° | ° | ° | ° | ° | ° |
| March . | 10·5 | 3·3 | 6·9 | 8·1 | 4 | 10·9 |
| April . | 15·2 | 7·8 | 11·5 | 8·6 | 4·3 | 15·8 |
| May . | 18·6 | 9·9 | 14·25 | 8·9 | 4·45 | 18·7 |
| June . | 21·8 | 12·9 | 17·3 | 4·2 | 2 | 19·3 |
| July . | 23·4 | 15·2 | 19·3 | 6 | 3 | 22·3 |

The same method brings out the mean for Orange, as stated above; and it is to be regretted that M. Gasparin should have printed his tables in so confused a form as to render it necessary almost to guess their import.

These calculations, the author admits, will not apply to places situated under very distant parallels of latitude. They are insufficient to explain how it is that the harvest takes place simultaneously in Sweden and around London, the summer temperature of London being 17·1° Centigr. (62·78° Fahr.), and that of Upsal 15·1° Centigr. (59·18° Fahr.). So, too, at Lyngen, within the polar circle, in 70° N. lat., where, away from the sea winds, there are good corn harvests; although the snow only disappears so as to permit the seed to be sown on the 10th of June, yet there is then a whole month of continual daylight, a most efficient agent in stimulating maturity, the short northern summers being remarkably clear.*

* Kæmptz and Pouillet establish, that when the sun is in the zenith only 70 to 80 per cent. of his rays reach the earth; and that the total number of rays that reach the ground, in the course of any serene day even, is only half of what fall on the atmosphere.

The observed thermometrical state of the atmosphere in the metropolitan counties of England will not confirm M. Gasparin's hypothesis, without some considerable modifications, as further experience and more numerous observations may present. Our temperatures for the months during which the corn is advancing range as follows:—

| | Fahr. | Cent. | | Days. | | Total Degrees. |
|---|---|---|---|---|---|---|
| | ° | ° | | | | |
| April . . | 46·9 | 5·3 | × | 30 | = | 159 |
| May . . | 54·5 | 12·5 | × | 31 | = | 389 |
| June . . | 58·2 | 14·6 | × | 30 | = | 438 |
| July . . | 61·8 | 17 | × | 31 | = | 528 |
| August . | 61·8 | 17 | × | 15 | = | 255 |
| | | | | | | 1·767° |

There remains the complement of purely solar heat to be added. The late Professor Daniell's Meteorological Essays contain an account of his observations during the years 1821 and 1822 of the *excess* of solar over atmospheric heat. The mean was as follows:—

| | Fahr. | | Cent. |
|---|---|---|---|
| | ° | | ° |
| April . . | 28 | = | 15·5 |
| May . . . | 30·5 | = | 16·9 |
| June . . . | 39·9 | = | 22·1 |
| July . . . | 25·8 | = | 14·2 |
| August . . | 33·1 | = | 18·4 |

If we halve the respective differences in the manner practised by M. Gasparin, and multiply them into the days in each month, there will be:—

| | | | | | Days. | | |
|---|---|---|---|---|---|---|---|
| April . . | $\frac{15\cdot5}{2}$ | = | 7·5° | × | 30 | = | 225° |
| May . . | $\frac{16\cdot9}{2}$ | = | 8·4 | × | 31 | = | 260·4 |
| June . . | $\frac{22\cdot1}{2}$ | = | 11 | × | 30 | = | 330 |
| July . . | $\frac{14\cdot2}{2}$ | = | 7·1 | × | 31 | = | 220·1 |
| August . . | $\frac{18\cdot4}{2}$ | = | 9·2 | × | 15 | = | 138 |
| | | | | | | | 1173·5 |

This sum of 1173·5 of solar degrees, added to 1767° atmospheric, obtained from the table above, makes 2940°—a greater amount than M. Gasparin obtains for either Orange or Paris.

In the arctic regions the difference of solar heat is far greater than in the temperate, and in the temperate than in the torrid zone. In the latter Humboldt never found it exceed 6°·6 Fahr.; but some of Mr. Daniell's observations in the neighbourhood of

London gave a difference of not less than 51°·5 on one day in June from 9 A.M. to 6 P.M., amounting indeed at 2 P.M. to as much as 67°·5.

Captain Parry remarked at Melville Island, N. lat. 74° 25′, on the 16th of March, during more than three hours, a difference of 50° Fahr. between a thermometer on the shady and one on the sunny side of the ship—the former being 22° below zero, the latter 28° above. Captain Scoresby observes, in his 'Account of the Arctic Regions,' "that the sun's rays frequently melt the pitch out of the seams of the ship on one side, while ice is forming on the other side, in the shade." Mr. Daniell ascertained, by covering the bulb of a thermometer with pitch, and exposing it to a gentle heat, that it required at least 120° to melt it. Here then the solar radiation could not have been less than 90° Fahr. or 50° of Centigrade.

These and other instances which might be adduced serve to show that M. Gasparin's proposition in its present form is inapplicable,* and that it is not practicable to determine the aptitude

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* This theory, which Gasparin adopts from Boussingault, originated with Réaumur, and was subsequently followed out by the Père Cotte (see 'Traité de Météorologie du P. C.,' p. 424, and the Mém. de l'Acad. des Sciences for 1735, p. 559). Quêtelet, however, considers that in estimating the action of heat on plants, the more correct method is to take the sum of the *squares* of the temperatures—since temperature is with reference to plants a *vital* force. In the notation of the calculus of finite differences, Quêtelet's method is expressed by $\Sigma\, t_n^2$.

Réaumur's by $\Sigma\, t_n$.

(the respective diurnal temperatures being supposed equal to $t$, $t'$, $t'$, &c., while $n$ represents the number of days reckoned from the first observed flow of the sap after the winter frosts, to the first expansion of the petals.)

Judging from Quêtelet's account (pp. 243, 244, in the first edition of his 'Lettres sur la Théorie des Probabilités,), of his observations upon the lilac, and his compared calculations according to the two methods respectively, that of the *sum of the squares* accords the most nearly with facts, and at any rate reduces the deviations within the limits of *probable error* (mathematically speaking). It is possible that M. Gasparin's data would lead to more consistent results if they were treated according to Quêtelet's theory, and it would be interesting if M. Gasparin could be induced to revise them with this view. Quêtelet's formula $\Sigma\, t_n^2$, when analyzed, leads to a remarkable result stated in a note of his appendix to the above work. If T be the *mean* of the diurnal temperatures observed during $n$ days, and $\Delta$, $\Delta'$, &c., the respective daily differences between the observed temperature and the mean T, then by a very simple algebraical development we deduce

$$\Sigma\, t_n^2 = n\mathrm{T}^2 + \Sigma\, \Delta^2$$

Thus $\Sigma\, t_n^2$ is obviously a function of T and of $\Delta$, and is of such a nature that (for any specified value of T) the first side of the equation will be greater the greater $\Delta$ is, and will be least when $\Delta$ is zero. That is to say, that departures from the *mean* are more favourable for developing vegetation than uniform temperatures: a most interesting deduction, should it be verified by facts; and it appears that Humboldt considers this corollary to be

of a locality for the growth of wheat by ascertaining only the mean temperature attained in the course of the day by the surface soil exposed to the sun's beams, unless we knew how that tempe-

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borne out by observations which have come under his cognizance—especially those respecting the King of Prussia's orange trees at Berlin. It is plain, however, that it is a law which can only obtain within certain limits of variation (limits differing no doubt for every individual species of plant). Observations upon this subject would be invaluable, and the following experimental problem may be laid down for vegetable physiologists:— To determine within what range of *variations from the mean* the development of vegetation is promoted for a given plant. There is a maximum value of $\Delta$, beyond which the plant would be injured or destroyed. The above corollary would at this point cease to be true (physiologically), and it may become a question if the formula of the *sum of the squares* does not then altogether cease to express the relations of temperature and vegetation.

On the hypothesis that a mean derived from certain variations is more promotive of vegetation than the same mean when resulting from greater uniformity in the range of limits, light may be thrown upon many anomalous phenomena. Sunshine may have an indirect, as well as direct, effect in exciting active vegetation, through the higher value of $\Delta$ which then necessarily results from the greater contrast of the diurnal and nocturnal temperatures.]

No universally accurate laws on the relations between climate and the development of plants can be obtained until a far greater range and mass of facts have been accumulated. Quêtelet proposes isanthesical lines (lines of *simultaneous flowering*). We require also lines of equal variation between the maximum and minimum temperatures, to compare with the isothermal lines. Quêtelet points out that every plant has its own numerical *constant* (or square of a certain number of degrees of heat), without which the phenomena of flowering, &c., cannot occur. For the lilac he fixed this at 4264° Cent. A similar determination of this constant for every species of plant would be an important element in the data for forming any exact and scientific agricultural theories. Such a table of Floral Constants might be for the enlightened agriculturist, in reference to some purposes, of scarcely less value than the table of Lunar Declinations, or that of Sines, &c., to the navigator. Its accurate determination connects itself with some of the most complex and subtle problems in physical science, viz., the calculation of the *quantities of heat*, solar and atmospheric, received in a given time on a given spot. Pouillet has paid great attention to this subject (in his Mémoire sur la Chaleur Solaire, &c.), uniting experiment with theory in his investigations, by means of his Pyrheliometer, which M. Gasparin seems to have chiefly used in pursuing his own observations upon this point. It does not appear what instruments beyond the common thermometer Quêtelet used in his experiments on the lilac and other plants.

To enter fully into explanations and applications of calorific formulæ in a paper like the present would be impossible: we will only slightly allude to a neat equation of Pouillet's, in which the *thermometrical elevation* caused by the direct solar action during a given number of minutes, is made a function of $e$, the *atmospheric thickness* traversed by the solar ray. That $e$ is itself a variable depending on $z$, the sun's zenith distance for the given place and instant of time, is obvious. If $t$ be the observed thermometrical elevation, reckoned in degrees Centig., Pouillet finds:—

$t = a\,p^e$ ($e$ entering as an *exponent* on the second side).

$a$ is a constant expressing the unvarying calorific power of the sun, elimi-

rature was to be calculated; and unless some account were taken of the constantly varying ratio of the periods in which the heat accrues, and for which the author has provided no formula. He does not even advert to it. In the high latitudes it would seem that some other agent is at work to supply the requisite vegetative power, the extent of whose function has yet to be determined.

Taking three places under different parallels whose mean hottest months are respectively 70°, 65°, 60° Fahr., which will nearly correspond to those of Toulouse, Berlin, and St. Petersburg, we shall see that the *total number of hours* during which the solar heat accrues ought to be considered.

At Toulouse, lat. 43° 36′, the July temperature is 70° (21°·1 Centigrade); the day, on an average, is $14\frac{3}{4}$ hours long.*

At Berlin, lat. 52° 31′, the July temperature is 65° (18°·3 Centigrade), and the length of day is the same as in London, 16·1 hours.

At Petersburg, lat. 59° 56′, the July temperature is 60° Fahr. (17°·1 Centigrade), and the day is 18 hours long.

If merely the number of days without reference to their length were calculated according to M. Gasparin's method, the results would come out thus:—

| | | Days. | | | Assumed Solar heat. | Half of do. as due to the day only. | Days. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Toulouse . | 21°·1 | × 31 | = | 654°·1 | 13 | 6°·5 | × 31 | = | 201°·5 | + 654°·1 | = | 855°·6 |
| Berlin . . | 18·3 | × 31 | = | 567·3 | 20 | 10 | × 31 | = | 310 | + 567·3 | = | 877·3 |
| Petersburg | 17·1 | × 31 | = | 530·1 | 25 | 12·5 | × 31 | = | 387 | + 530·1 | = | 917·1 |

But if the proportion of solar, not atmospheric, heat were com-

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nation made of all modifying forces, such as the absorptive influence of the atmosphere, &c. $p$ is also a constant, but is determined by conditions which are invariable for very limited periods only. It expresses the transmissive power of the atmosphere, and is obviously constant only for a given time and corresponding condition of that atmosphere. Pouillet calls $a$ the *solar constant*, $p$ the *atmospheric constant*. He has obtained the above general formula from numerical equations furnished by the tabulated results of observations carried on during some years. In these equations $t$ and $e$ were the *known* quantities, the values of $t$ being given by the pyrrheliometer, the values of $e$ by astronomical and trigonometrical formulæ. $a$ and $p$ were the two *unknown* quantities to be determined.

These reasonings and computations seem to contain the elements of correctness, and the equation probably expresses the true physical relations. He makes it the basis of many important deductions respecting the aggregate sums of heat received during certain periods—hours, days, months, or seasons—by the earth's surface; computations which of course necessitate reductions for *obliquity of the rays* as well as other corrections. Any notice of these further conclusions, or discussion of their value and exactness, is however here inappropriate. A. A. L.

| | | | | |
|---|---|---|---|---|
| * Sun rises at Toulouse, July | 1, 4 h. 24 m.; | sets 7 h. 36 m. | day = 14 h. 49 m. |
| | 31, 4 47 | 7 13 | |
| Petersburg, „ | 1, 2 50 | 9 10 | day = 18 0 |
| | 31, 3 40 | 8 20 | |

puted from the number of hours during which the sun actually shines in those several latitudes, the account would stand very differently.

| | Sum of Atmospheric Temp. in July. | Mean Solar Heat. | Hours out of the 24. | | | Total July Temperature, from solar and atmosph. |
|---|---|---|---|---|---|---|
| Toulouse | 654°·1 | 13 × | 14·75 ÷ 24 = 7°·99 | × 31 | 247°·69 + 654·1 = | 901°·7 |
| Berlin | 567·3 | 20 × | 16·1 ÷ 24 = 13·37 | × 31 | 414·47 + 567·3 = | 981·7 |
| Petersburg | 530·1 | 25 × | 18 ÷ 24 = 18·75 | × 31 | 581·25 + 530·1 = | 1111·3 |

In the above tables the mean temperatures are extracted from Mahlmann's tables published in Kæmptz. The solar heat is deduced from Daniell, Scoresby, and others; and, though entirely hypothetical, it is probably within the mark.

Here there appears in a single month a difference of nearly 200° of the Centigrade in computing the degree of heat available for vegetation at Petersburg above that of Toulouse, and more than 100° in that of Berlin.

The growth of maize is brought forward by M. Gasparin in support of his conclusions respecting solar heat. It ripens imperfectly at Paris, but very well in Alsace. The mere difference of temperature is insufficient to account for the fact. This grain sown at Orange in the beginning of April is harvested there in September, after having received, as his instruments indicate, 4108° of heat. In Alsace it ripens in October; at Paris on the 1st of November, with 4000°, as measured by the same instruments. M. Gasparin attributes the superiority of Alsace to its enjoyment of a brighter sky than at Paris. The thermometrical means are very similar; Mahlmann's tables show them as follows:—

| | Mean Temperature. Spring. | Summer. | Autumn. |
|---|---|---|---|
| Paris | 10°·3 | 18°·1 | 11°·2 |
| Strasburg | 10 | 18·1 | 10 |

Indeed the difference is at first sight in favour of Paris; but the excess of solar heat derived from the greater number of bright days that shine upon Strasburg is to be taken into account; the estimation, however, of two bases so shifting and variable in themselves is liable to considerable error.

Although M. Gasparin does not explicitly demonstrate the truth of his theory, yet the facts he has advanced* may invite the

* In p. 126 of Mons. Gasparin's 2nd vol. (Section 'Sur la Formation des Nuages'), he remarks that a numerical expression for the *nebulosity* of climates would be important; and in the chapter at p. 213 ('Répartition de la Lumière,' &c.) this subject is again particularly alluded to.

M. Gasparin remarks justly, that there are three ways of treating it practically:— 1. By

attention of those who possess any additional data for comparing the different rates of progress towards maturity made by the same plant under different meteorological conditions, so as to reconcile the anomalies which now appear to exist. The whole study of the phenomena connected with the processes of germination, foliation, flowering, and maturity, is extremely interesting. Some years ago the Academy of Bruxelles recommended the formation of an accurate record of observations,* embracing

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1. By observation of the *quantity of light* we receive.
2. By ditto of the *solar heat* received.
3. By direct observation of the *extent and mass* of the clouds themselves.

The *last* method is obviously the least practically feasible, and would be by no means the most productive in its *results* if attained. The agriculturist requires a measure of the *effects* of the clouds at a given instant upon the transmission of light and heat. Now the same amount of these *effects* may result at different times from totals of cloud infinitely varied both as to their component masses, and their distribution over the heavenly vault. This mass and distribution, supposing it *could* be accurately and easily determined for every given instant, is in fact a differential which we have no certain law for *integrating*. And it is the *integral* which the agriculturist here requires.

A comparison of the two other modes of observation for a given time would offer a complete measure of nebulosity in its integral effects. As regards the determination of calorific action, Sir John Herschel's actinometer (since he has improved it by the *insertion of an internal thermometer*) offers advantages over Pouillet's pyrrheliometer, &c. M. Gasparin is probably unacquainted with this perfected actinometer; and equally so with the *actinograph* (described in *Art.* VIII. of Sir John Herschel's paper, Phil. Trans., 1840, "On the Action of Light upon Preparations of Silica.") This latter instrument includes a *heliograph* and *nebulograph*, worked by one and the same clock-movement. Mr. Jordan (mathematical and philosophical instrument maker, &c., &c.) has further perfected the application of the photographic principle to the purposes of accurate self-registration. The *actinograph*, with Mr. Jordan's ingenious *scale* added to it, would measure *light* to a numerical nicety as complete as that of the actinometer, or other *calorific* instruments, and it possesses the great additional advantage of *self-registration.*

This is not the place to enlarge upon the suggestions of Sir John Herschel or others, towards the yet further applications which may be made of various principles (*e.g.* that of the cryophorus) for constructing meteorological instruments of the utmost delicacy. The subject is a very extensive one, and would form an essay of itself, if treated with any approach to completeness.

The present object is merely to suggest to M. Gasparin (and to other scientific agriculturists) how accurately the two instruments above named —the *actinometer* and *actinograph* (the latter having Mr. Jordan's scale added)—would supply the desired data, as regards *light* and *heat*. M. Gasparin seems to write unaware of the means which photography has offered towards the easy and delicate appreciation of degrees of *nebulosity*, and he would doubtless be the very first to estimate and apply the principle to this important purpose, since he dwells with peculiar and just emphasis on the deficiency hitherto.—A. A. L.

* Such observations require to be compared with the utmost care, and

those plants most generally diffused over an extensive geographical range. Schubler, who investigated this subject, concluded that, *cæteris paribus*, every additional degree of latitude caused a delay of four days in the period of flowering. So that the same plant blossoming on a certain day at Parma would flower six days later at Munich, thirteen at Tubingen, twenty-five at Berlin, thirty-three at Hamburg, and fifty-two at Christiania. But towards the Arctic Circle the greater duration of the summer day develops vegetation more quickly, and in fact the difference between Christiania and Hamburg is only three or four days instead of nineteen.

Height also has its share in modifying heat. Schubler deduced from his experiments in Saxony that every 98·26 feet caused the following delay in

| | Flowering. Days. | Harvest. Days. |
|---|---|---|
| Wheat . . . | 2·2 | 2·2 |
| Barley . . . | 1·3 | 2·2 |
| Oats . . . | 2 | 2·2 |
| Potatoes . . | 2·3 | 0·5 |

But he observes that the same difference would not be found between a plain habitually covered with fog and a mountain perfectly clear, or between a plain and a mountain equally clear.*

many years must elapse before we can deduce from them the mean relations of one climate or latitude to another.

From six years' observation, M. Quêtelet deduced the mean time for the flowering of the lilac at Bruxelles to be the 27th·5 of April; but in the course of those six years there was a difference of twenty days between the earliest (20th of April) and the latest (10th of May). In order to establish even an approach towards a basis, the number of years of observation ought at least to equal the term of the greatest divergence. In his 'Lettres sur les Probabilités,' M. Quêtelet has given a table (p. 248) of the flowering of the same plant for several other places; but as yet the number of years is so small, that, as he himself admits, no great reliance can be placed on such a comparison. For instance, at Parma, from two observations in 1843 and 1844, he fixes it for the 19th of April; at Gand, from four years only, the 1st of May; at Prague, from four years also, the 10th of May; at Munich, from three years, the 10th of May. In the neighbourhood of Cambridge, from *one* observation, he fixes it for the 9th of May, or rather for ten days later than Bruxelles. Yet at Swaffham in Cambridgeshire (see Farmers' Almanac for 1848), Mr. Jenkyns found, from a mean of ten years, that the lilac flowered there on the 30th of April, that is 2 days or 2·5 days later than M. Quêtelet's mean of Bruxelles. Swaffham is just four degrees more to the north than Bruxelles.

* Gasparin gives the following rule for calculating the decrease:—D, decrease; $t$, temperature of the plains below ascertained; $t'$, that of space ($-52°$ Cent.): then for the first 1000 metres ( ) $D = \frac{t-t'}{11} \times \frac{10}{11}$. For the Asiatic continent we should have for 1500 metres $D = \frac{t-t''}{4}$; for 2500 metres $D = \frac{t-t'}{7 \cdot 7}$.

The mean decrease of temperature observed on an average of five aërial voyages (including the celebrated ascent of Gay-Lussac to the height of 22,632 feet) has been 1° Fahr. for every 360 feet of elevation.

In the south of Germany and north of Italy every 310 feet causes a decline of 1° Fahr.; in the United States it is 404 feet, in Siberia 440 feet.

Before quitting the subject of heat, it may be as well to remark the extraordinary halt in the increase of the temperature between the 10th and 13th of February, and again from the 8th to the 13th of May, which has been noticed in France as well as in England, and there attributed to the intervention of asteroides between the sun and earth during those periods.

There is also little increase of heat from the 25th of March to the 15th of April at Paris, but thenceforward the rise is irregular; the curve of the descent of temperature in the autumn is much more uneven than that of its ascent in the spring. There appear to be two maxima of heat, one at the beginning, the other at the end of July, owing, probably, to that month being generally showery, which of course have their effect in lessening its warmth.

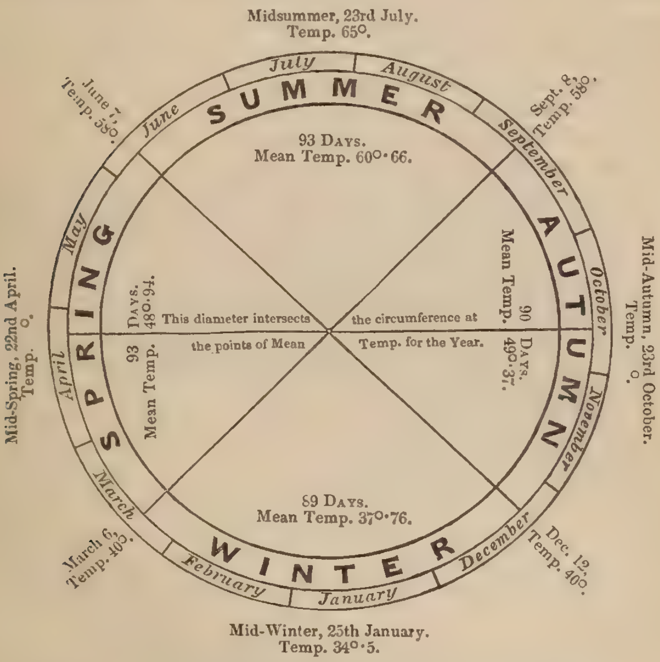
M. Gasparin would make the middle of winter coincide with the coldest period of the year, and that of summer with the hottest. Our seasons do not do so according to their present nominal distribution. The mean maximum of cold occurs at Paris, as at London, about the middle of January. Taking that as the centre of winter, he would assign the 1st of December as the commencement of that season—the 1st of March for that of spring—thus making each coincide with three calendar months. This would be a less inconvenient change than that proposed by Mr. Luke Howard, who would have all our seasons commence fifteen days earlier than the equinoxes and solstices. Winter, then, by his scheme, would begin on the 7th of December, lasting to March 5th, during which time the mean daily temperature in the neighbourhood of London will have fallen from 39·81° (Fahrenheit) to 34·55°, rising again to 39·94°. The vernal quarter occupying ninety-three days to June 6th, would have risen 18·14°, to a temperature of 58·8°.

Summer would rise to 64·75°, declining to 58·16° by the 7th of September, when the autumn would begin. During the three next months the temperature would decline 18·35°, the same number of degrees, within a small fraction, that it rose in the spring.

This division might introduce some perplexity into our calendars, but it is no doubt more exact and methodical than our present arbitrary derangement of nature. The mean greatest cold and the mean greatest heat would then form the centres of the winter

and summer seasons, while the two periods at which the average ascent of the temperature in spring and its descent in autumn respectively intersect the line of mean annual temperature would form the centres of the spring and autumn quarters. The extremes generally follow, according to L. H., about a month after each solstice; the means about the same interval after the equinox—that is, the average yearly mean coincides with the daily mean observed about the 24th of April and the 23rd of October, which, by his proposal, would become the middle of spring and the middle of autumn.

The accompanying diagram explains better to the eye the foregoing description. The middle point of each quadrant contains respectively the maximum and minimum and the two means of the annual temperature.




It has been shown that the continental summers, though hotter than our own, are by no means exempt from mischievous alternations. Among those most destructive may be reckoned those sudden changes in the upper strata of air which give rise to the hail-storms, to which all France and North Italy is more or less exposed. It has been remarked that some parishes are only visited thus after considerable intervals of time; others every

three or four years; others every year; and in the afternoon rather than the forenoon. "Often," says M. Desperre,* "the hail-bearing column of cloud issues by some gorge or defile;" and adds that it is suspected that this phenomenon has occurred more frequently of late years, since those defiles were stripped of the forests which once crowned their summits. De la Rive's opinion M. Gasparin thinks well-founded—that the formation of hail and the development of electricity are referable to a common cause—the result of the meeting of two currents of air of different temperatures from opposite quarters of the heavens. "The hail-bearing column will sometimes be deflected by an elevation—be precipitated into a valley—as it comes from the meeting of a warm wind (in most parts the south-west) with a cold one, it would follow that those districts which are protected towards the south-west by a chain of hills will suffer less than others exposed to that quarter. There were in the Piedmontese dominions, in 1840, the following number of storms:—

| | Savoy. | Piedmont. | Liguria. |
|---|---|---|---|
| | 39 | 103 | 47 |
| Of which | 34 | 61 | 18 |

fell in the months of June, July, and August.

Their geographical distribution appears to favour the conjecture advanced by M. Gasparin—the smallest number occurring in Savoy, where the great barrier of the Alps would check the arrival of the south-west winds; the greatest in Piedmont, which is most open to that quarter. Liguria has an intermediate number; though exposed to the south-west, and extended along the Apennines, the influence of the sea air probably tempers those sudden changes that happen elsewhere.

We collect from this work some curious particulars respecting the rains, which occur most plentifully in regions to the southward and westward of mountainous ranges, and the more so the nearer those ranges are to the great reservoirs of humidity: they diminish in the lands of plains. The central and southern portion of Europe has more rain in summer than in the autumn, until the parallel of the British islands is reached, where the chief fall is in the autumn.

The quantity of rain is of less consequence than the frequency with which it occurs, and the periods over which it is spread. At Lancaster, Penzance, and Truro there are commonly 159·5 days† in the year in which it rains; along the coast of France 139·7;

* In a paper read before the Royal Academy of Turin, 1844.

† M. Gasparin does not state his authority for this. Howard's 'Climate of London,' i. p. 103, gives, as the mean of twenty years, 178 rainy days for the neighbourhood of London.

Northern France and Germany 144·9; Italy, north of the Apennines, 101·2; Southern France and Italy 91·2 days.

The average fall in a rainy day in England is ·2322 inches; in Western France ·2122; Northern France ·1847; Northern Italy ·3853 inches.

The length and character of the intervals between the rains is another important ingredient in determining the climate and capabilities of a country. Where the rains, though light, are frequent, the sky is naturally cloudy; there will be little heat and little evaporation where rainy days are rare; but where the quantity which falls on each day of rain is considerable, there the usual character of the atmosphere will be clear and bright, promoting rapid evaporation. At Paris the mean of the intervals between the rainy days for the whole year is 4 days; at Orange 4·6; at Niccolosi, in Sicily, 10·8 days. "A climate cannot be said to be a dry one because it has only a small amount in depth of inches of rain; but if a country were to receive 3·3 inches of rain in one single day, in every month of the year, it would be a very dry one, for that water cannot have impregnated the soil, but will have run off into torrents from its surface, and the terrestrial evaporation, increased by a bright sky, will soon cause the rest to disappear."

Few points, indeed, are of more importance than the hygrometrical condition of the soil and atmosphere, as influenced by these two opposite agents. An artificial permeability (effected by draining) of a naturally plastic and retentive earth may render it far less mischievously affected by an excess of wet than another description of earth less retentive, but where industry and skill have done nothing to promote the slow natural percolation to which it is abandoned. In the absence of other modes of relief, the excess of moisture can only be carried off by the tardy process of evaporation. This, in the neighbourhood of London, is more than equal to dispose of the whole of the rain that falls in the course of the year. The average depth in inches is calculated by Mr. Daniell to be 22·199, and the power of evaporation equal to 23·974; but of these quantities more than 12 inches (12·13) fall in the months of November, December, January, February, March, April, and May, while the corresponding evaporation during the same period amounts only to 9·47 inches, leaving, even at the end of May, an excess of 2·66 inches of moisture in the soil.* Putting aside the mechanical difficulties in the way of cultivation on land saturated with and retentive of

* Mr. Josiah Parkes calculates that, of the whole annual rain, 42½ per cent. (11·3 out of 26·5 inches) filters through the soil, and that the annual evaporative force is only equal to the removal of 57·5 per cent. of the total rain that falls on any given extent of surface.

wet until so late a period of the season for vegetation, we find then that on practically impervious soils, where this measure of humidity is retained within a short distance of their surface until the commencement of June, the power of the soil and heat of the sun are neutralized until that period by the attempt to free it from the effects of the winter's rain. Thus much of the season is in point of fact lost; to say nothing of the advantage of fully replenishing those lower recesses of the soil by which moisture may be retained in reserve, at a proper distance beneath, against the parching droughts of the summer, in even these northern countries.

Some recent observations have aided in increasing the apprehensions long felt by scientific men in France and Italy with regard to the progressive stripping of the mountainous districts of their woody clothing: thinking that the earth, when deprived of the natural reserve of moisture which these forests preserve among the heights in which they grow, devastated by the unchecked torrents which descend from them in the season of rains and thaws, parched by the torrid action of the summer sun, will not only cease to produce, but be the means of visiting with desolation (by the rapid whirling down of the materials that compose them) the fertile plains below.

Berghaus collected a series of observations on the two rivers the Elbe and the Oder. On the latter, from 1778 to 1835, the volume of water has been gradually diminishing. On the Elbe the same thing has been remarked from 1728 down to 1836. Judging from the rate of decrease, Berghaus predicted that if it continued as it had done since 1781, it would be necessary to change the form of the boats on the Elbe for others drawing less water. The same thing had been remarked on the Volga. At the beginning of the last century the boats that carried salt could ship 300,000 kilograms of that commodity; they can now, as we are told, only transport 180 000. It was at first supposed that the decrease might be due to the stripping of the mountain sides, and the gradual disappearance of the forests from their slopes; but Merian observed that every succeeding mean of ten years on the Rhine exhibited a decrease of volume, and yet, on its upper portion, the forests have not been much impaired; and as the river itself is mainly supplied by the melting of glaciers, other causes must be sought for. Nor has the increase of the tillage, or the destruction of wood on the Ural mountains, been sufficient to account for this, when we consider the immense basin which the Volga drains. It may then be a question whether the quantity of rain has diminished. As far as can be inferred from registers kept in different parts of the continent, it is rather the reverse of this. For one hundred years, from 1689, the annual fall at

Paris was 18·38 inches; during the last forty years the average has been gradually increasing: it is now 20·86 inches.

At Milan, from 1763 to the present time, the records of meteorology show an increase from 36·81 inches to 40·66 inches.

At La Rochelle the average from 1777 to 1834 was 28·11 inches; from 1835 to 1840 it has been 28·87 inches.

In the valley of the Rhone, according to Flauguergues, the mean of decennial periods has been as follows: 1787, 33·14 inches; 1797, 35·39 inches; 1807, 36·45 inches; 1817, 40·66 inches.

These figures all point the same way, and indicate a tendency to increase from the shores of the Bay of Biscay to the centre of Europe. Can it have been from a change in the character of the rains, their diffusion over a greater length of period in falling and through a greater number of days? For a constant succession of heavy showers, falling closely one after the other, supplies a greater quantity of water to streams and rivers than when the same quantity falls in the course of many days, separated from each other by dry intervals; for the land has then time to dry and can absorb the moisture, which comes gently down, without permitting it to run off the surface.

The effects of Enclosure Acts in this country certainly tend to alter the conditions of our rivers, and those effects will be still further increased by the operations of agricultural drainage, now so generally proceeding throughout the country. In both cases the result has been the rapid delivery of a large quantity of water, which formerly remained stagnant in the ground till evaporated by the summer heats, slowly draining off meantime from below into the rivulets to which they acted as natural reservoirs—springs from which a slight supply continued to be afforded till the autumn. During the height of agricultural enterprise in the war-time the enclosure of commons became very frequent; and though draining was not systematically practised, yet the mere fencing and division into fields of 10 or 15 acres by means of hedges and ditches did, as far as their influence reached, effectually draw off a large quantity of what would otherwise have remained much later in the soil. Many streams in consequence, which used to flow during the whole summer, are now dry before the middle of May. The annual volume of water carried down by our rivers to the sea may be the same as before; but the effect of the drainage, when complete, will be to alter the times in which that volume is to be conveyed; it will be less evenly diffused, the contributions will arrive more hastily and in larger quantities within short given periods than formerly. It is now commonly said in praise of the improvement and as a proof of the skill and success with which it has been carried out, that

the downfall of any heavy winter's rain ought to have all been filtered through the soil and carried off by the drains within twenty-four hours after the rain has ceased to fall. It will not be surprising then, under such circumstances, as the beds of our rivers will be called upon to do double duty at no distant time, to find that in some parts of the country bridges have to be rebuilt, water-ways widened, and that artificial defences against the rapidity of the current or the encroachments on the banks have to be strengthened. The spread of inundations, which may also be anticipated in our great river-basins, is an evil not so easily dealt with, as there are no means of adequately raising the soil above the level of the waters. This indeed appears the only drawback, and it is a serious one, as it affects many places, towns, and residences, which even now are subject to periodical floods, some of them very formidable; there is then a temptation to embank, but this is only a temporary remedy: since by confining the river waters to the immediate vicinity of the channel they usually occupy, the adjacent lands lose the advantage of that deposit which would at last by degrees raise their level; while that of the river itself is, by the alluvial matter brought down by the current, gradually but surely elevated above the level of the surrounding country, as may be seen throughout the north of Italy. M. Gasparin is not satisfied that the stripping of the mountain sides of their forests will account sufficiently for the lessened quantity of water in the rivers of Europe. He thinks that the influence of cultivation, by rendering the earth more porous and absorbent, may have a large share in causing it; but that, on the whole, "their annual volumes depend on certain unknown periods, which periods cause certain winds more or less rainy to alternate with others; a distant future, when a long series of observations shall have been made, will alone permit us to see whether there is any regularity in the return of these periods."

As to their effect on vegetation, "The earth ought to have not less than $\frac{2}{5}$ of an inch* of water within 1 foot† of the surface in the summer, and never more than $\frac{9}{10}$ within the same distance in winter.‡ In order to ascertain the depth to which rain penetrates, M. Gasparin instituted some experiments, from which he concludes that through a perfectly dry argillo-calcareous soil, in a state of fallow, rain descends in one day six times the depth of the quantity fallen. Thus, a fall of $\frac{4}{10}$ of an inch will sink in a day through nearly $2\frac{1}{2}$ inches of the particular soil in the condition which he described.

It is only by very slow absorption that it can insensibly furnish

* In strictness, 0·10 = ·3937 of an inch.
† 30 Cent. = 11·81. ‡ 0·23 = ·9055 inch.

moisture to the closer strata below, during which, in the summer months, the atmospheric evaporation is powerfully struggling against the attraction of the earth. However, some absorption does take place, even among what are termed impermeable subsoils, and some retention among the most porous; since it is found, on cutting to any depth in the driest seasons, that a certain degree of dampness remains, which, at a few feet below the surface, the earth appears never to lose.

Has the moon any appreciable influence in determining the character of the weather? Notwithstanding the ridicule which sometimes attaches to the vulgar belief in it, the celebrated Arago did not disdain to examine into the question. At Carlsruhe, Orange, and Paris the meteorological registers concur in marking a slight predominance of wet during the whole of the first quarter.

There have been various theories in this and other countries respecting the lunar action. In Howard's 'Climate of London' great importance is attached by the author to the declination north or south of our satellite. Another weather-table, incorrectly ascribed to Sir William Herschel and Adam Clarke, assumes that the nearer the moon becomes new or full to midnight the fairer the weather; the nearer to midday the greater the liability to wet.

M. Arago, from a careful comparison of tables compiled by observers in different parts of Europe, finds that the rain falls oftener during the increase than the wane of the moon by 6 to 5; this is more particularly the case from the first quarter to the full moon, *i. e.*, about the second octant. This is confirmed by Schubler. Out of 1200 observations of wet days, occurring during twenty years at Stutgardt and Augsburg, he found that while the mean of the days of the four quarters and their intermediate octants, with one day following each, gave 140 wet days, the second octant and the day following it gave 165; or a probability of 8¼ to 7 in favour of rain at that period of the month.

At Vienna, out of 100 repetitions of each phase of the moon (= 8 years), there was a marked prevalence of wet as follows:—

| | | | Rains. |
|---|---|---|---|
| When the full moon occurred in perigee | | . . | 81 |
| ,, new moon | ,, | ditto . . . | 80 |
| ,, full moon | ,, | apogee . . | 68 |
| ,, new moon | ,, | ditto . . . | 64 |

Mr. Howard's theory was, that when the moon was coming north across the equator, and while in full north declination, there was more rain than when she was going southward.

In 355 days of observation in 1807, he found that there were the following quantities of rain:—

| | | |
|---|---|---|
| In the quarter coming north | . . . . | 4·96 |
| " " full north declination | . . | 6·67 |
| " " going south | . . . . . | 3·72 |
| " " full south declination | . . | 3·56 |
| | | 18·91 |

In 355 days of observation in 1816, he found that rain fell as follows:—

| | | |
|---|---|---|
| In the weeks about the new moon | . . | 6·11 |
| " " first quarter | . . | 10·10 } * |
| " " full moon | . . | 9·13 } |
| " " last quarter | . . | 5·51 † |
| | | 30·85 |

The Table in page 337 shows during the first nine months of this year:—

1st. The periods when the moon was in perigee and apogee, to which a wet and dry influence has been ascribed.
2nd. Those of its north and south declination (L. Howard).
3rd. Those of its second and fourth octants (Arago and Schubler).
4th. Those at which it becomes new and full, according to the hypothesis adverted to above, and which is given in Johnson's 'Farmer's Almanac,' p. 54.

It will be seen, however, that none of these ingenious speculations can be of any practical service to the agriculturist as indications of the weather he is to expect, since on the hypothesis of their all having an effect, the preponderance singly due to any one of these phases is so frequently counteracted by the opposition of some of the others that the results must be altogether negative.

For instance, the rainy tendency of a full north declination may be neutralized by the opposite influence attributed to the last octant. This occurred on the 1st of May, as will appear from the table and average which follow. On that occasion it was dry.

Again, on the 29th of June and 27th of July, with the same position, it was wet.

Out of 20 periods of perigee the hypothesis was right 11 times and wrong 9 times.

Out of 20 periods of north and south declination, it was right 10 times and wrong 10 times.

Out of 18 periods of second and fourth octants, it was right 10 times, wrong 7 times, 1 uncertain.

These are best illustrated for the facility of comparison by the accompanying diagram.

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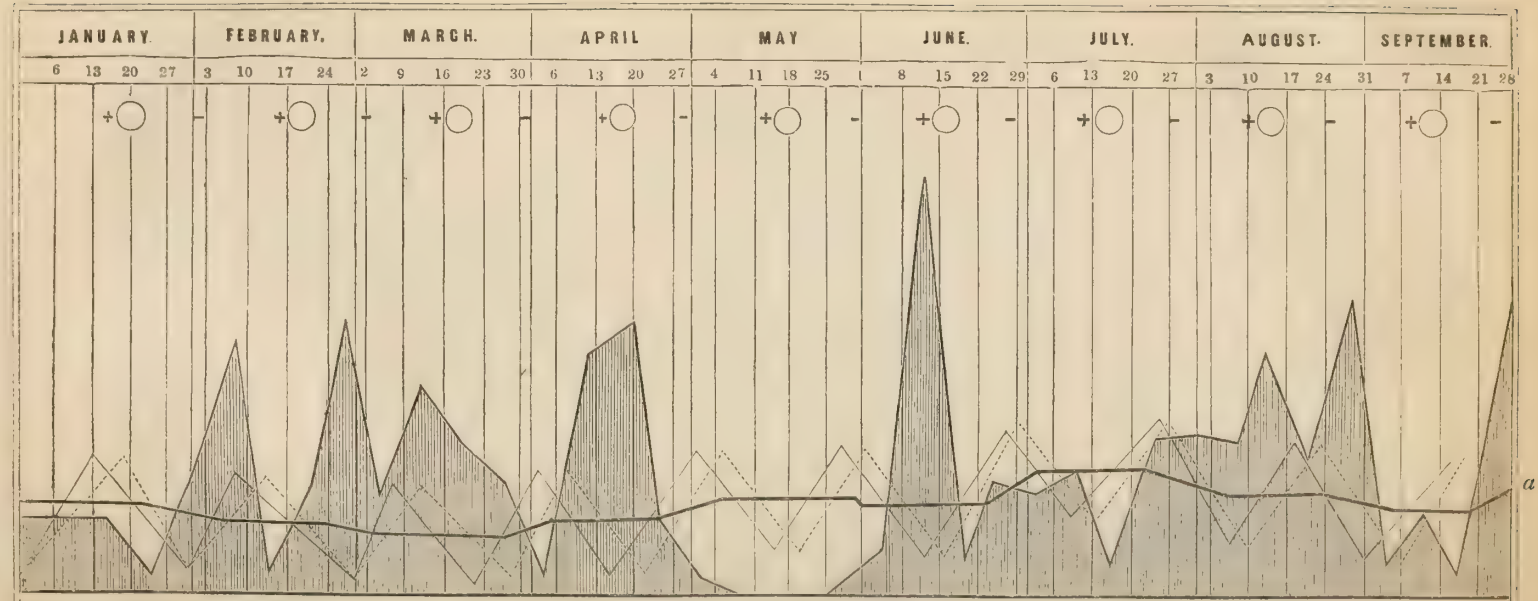
* This embraces the second, or, according to Schubler, *wet* octant.
† This comprises the dry octant.

| Months. | Perigee and Apogee. | Declination. | Octants. 2nd +. 4th −. | Time of Change of New and Full Moon. | | | Weekly fall of Rain. | | Total per Month. | Average of 34 Years. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | h. m. | Day. | Rain. | Inches. | Inches. |
| Jan. | (R.) 13 P. | (W.) 5 S. | 16 (R.) + | 6 (R.) | N. | 0 8 p.m. (R.) | 6 | ·32 | | |
| | | | | | | | 13 | ·32 | | |
| | (R.) 27 A. | (R.) 18 N. | 31 (R.) — | 20 (R.) | F. | 0 5 p.m. (W.) | 20 | ·33 | | |
| | | | | | | | 27 | ·00 | ·97 | 1·90 |
| Feb. | (R.) 8 P. | (W.) 1 S. | 15 (W.) + | 5 (R.) | N. | 1 42 a.m. (R.) | 3 | ·34 | | |
| | | | | | | | 10 | 1·31 | | |
| | (W.) 24 A. | (R.) 14 N. | | 19 (R.) | F. | 3 57 a.m. (R.) | 17 | ·07 | | |
| | | (W.) 29 S. | | | | | 24 | ·53 | 1·25 | 1·49 |
| March | (R.) 7 P. | (R.) 12 N. | 1 (W.) — | 5 (R.) | N. | 1 17 p.m. (R.) | 2 | 1·32 | | |
| | | | | | | | 9 | ·50 | | |
| | (W.) 22 A. | (W.) 27 S. | 16 (R.) + | 19 (R.) | F. | 9 11 p.m. (R.) | 16 | 1·06 | | |
| | | | 30 — | | | | 23 | ·76 | | |
| | | | | | | | 30 | ·52 | 4·16 | 1·39 |
| April | (W.) 2 P. | (R.) 9 N. | 14 (R.) + | 3 (F.) | N. | 11 1 p.m. (D.) | 6 | ·01 | | |
| | | | | | | | 13 | 1·22 | | |
| | (W.) 17 A. | (W.) 23 S | 28 (R.) — | 18 (R.) | F. | 2 31 p.m. (R.) | 20 | 1·38 | | |
| | | | | | | | 27 | ·38 | 2·99 | 1 84 |
| May | (R.) 2 P. | (R.) 6 N | 13 (W.) + | 3 (R.) | N. | 7 15 a.m. (W.) | 4 | ·12 | | |
| | (R.) 15 A. | | | | | | 11 | ·00 | | |
| | | (R.) 20 S. | 27 (R.) — | 18 (R.) | F. | 6 42 a.m. (W.) | 18 | ·01 | | |
| | (R.) 29 P. | | | | | | 25 | ·02 | ·15 | 2·00 |
| June | (W.) 12 A. | (R.) 2 N. | | 1 (R.) | N. | 2 40 p.m. (R.) | 1 | ·22 | | |
| | | | | | | | 8 | ·18 | | |
| | (R.) 28 P. | (W.) 17 S. | 12 (R.) + | 16 (R.) | F. | 8 53 p.m. (R.) | 15 | 2·12 | | |
| | | (R.) 30 N. | 25 (R.) — | 30 (F.) | N. | 10 19 p.m. (W.) | 22 | ·16 | | |
| | | | | | | | 29 | ·58 | 3·26 | 1 94 |
| July | (W.) 10 A. | (W.) 14 S | 11 (R.) + | 16 (R.) | F. | 9 21 a.m. (R.) | 6 | ·48 | | |
| | | | | | | | 13 | ·61 | | |
| | (R.) 25 P. | (R.) 27 N. | 25 (W.) — | 30 (R.) | N. | 7 25 a.m. (R.) | 20 | ·11 | | |
| | | | | | | | 27 | ·77 | 1·97 | 2·55 |
| August | (W.) 6 A. | (W.) 10 S. | 9 (R.) + | 14 (R.) | F. | 8 16 p.m. (R.) | 3 | ·81 | | |
| | (R.) 19 P. | (R.) 24 N. | 24 (W.) — | 28 (R.) | N. | 7 1 p.m. (R.) | 10 | ·79 | | |
| | (W.) 31 A. | | | | | | 17 | 1·22 | | |
| | | | | | | | 24 | ·62 | | |
| | | | | | | | 31 | 1·48 | 4·9[illegible] | 2·15 |
| Sept. | (R.) 15 P. | (W.) 7 S. | 8 (W.) + | 13 (R.) | F. | 6 18 a.m. (W.) | 7 | ·11 | | |
| | | | | | | | 14 | ·33 | | |
| | | (W.) 20 N. | 23 (W.) — | 27 (R.) | N. | 9 35 a.m. (R.) | 21 | ·03 | | |
| | | | | | | | 28 | 1·37 | 1·84 | 2·29 |
| Oct. | (W.) 1 A. | | | | | | | | 21·51 | 17·55 |

(R—right.) (W—wrong.)

In regard to the supposed connection of the weather with the hours of the day or night at which the moon becomes new and full, it appears that in 19 times this hypothesis was right, or nearly so, 13, once doubtful, and 5 times wrong. The irregularity of these periods forbids their being conveniently expressed by an average; but the place of the full moon itself is shown for the sake of noticing whether any apparent effect is produced by it, as some of the observations indicate a tendency to fair weather at that time. Out of 9 full moons during the present year the weather, during 6 of them, has rather favoured the notion, in 3 it has been contrary. This inclination to a cloudless sky, particularly during the time that the full moon is above the horizon, has been




The shaded portion denotes the *weekly* amount of rains in 1848 observed at Chiswick.
The line *a a* denotes the average *monthly* fall, from the observations of 34 years. (L. H.)
Times of Perigee and Apogee . Time of North and South Declination .

Period of Full Moon ○.
2nd octant, wet +.
4th octant, dry —.

noticed by Sir John Herschel:* and it appears to be connected with another attribute of that phase in the spring of the year, much dreaded in France, and known as the "lune rousse."† This unlucky name is given to the full moon which occurs in the latter part of April or the beginning of May, *i. e.* during that season in which vegetation has sprung up into activity and yet is very susceptible; in which the temperature still descends very low at night after a hot parching day. This excessive difference between the solar radiation by day and the corresponding terrestrial radiation by night is greatly promoted by the clear atmosphere which has been supposed, with much reason, to characterise the few days immediately about the full moon.

The effect of the moon may be more evident in climates where rainy days are comparatively few, and yet imperceptible in latitudes like our own, where, owing to other causes, they are frequent. The chances of rain are then of course proportionably augmented, wholly independent of any real or supposed lunar agency. At Lancaster and at Penzance, where it rains 167 days in the year, there is double the probability that there is at Montpellier, which has only 81, or Perpignan, which has 70; and more than four times the likelihood that it will rain compared with Toulon (40) and Messina (37).

The precise nature of the moon's influence has never been exactly substantiated, though it has been more or less believed in old as well as modern times, and in distant countries not deriving

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* See Sir John Herschel's forthcoming work, entitled 'Outlines of Astronomy,' p. 261; and also the Athenæum for 1836, No. 499, p. 360. I have been permitted by the kindness of Sir John Herschel to peruse extracts from his diaries relating to the character of the weather, observed during 80 full moons. The prevalence of a serene unclouded atmosphere, while the moon is so nearly full as to appear round to the eye, and is actually above the horizon, is very striking—a bright moonlight night often intervening between days otherwise consecutively cloudy and wet. Supposing this to take place equally in other parts of the temperate zone, it would corroborate and explain the diminished tendency to rain, observed as above, since the interval in every day towards that period, in which there is a probability of rain, is at once reduced to one half by the elimination of all those hours during which the moon so 'round to the eye' is visible.

This is of more practical use to the wayfarer than to the agriculturist, since the character of the weather by night, as far as his operations are concerned, is of less consequence than that which occurs by day; though no doubt the liability to frosty nights at particular seasons, which accompanies the full moon, may occasionally render it advisable to anticipate or delay the sowing of certain crops by two or three days, in order to avoid the damage of which a particular stage of germination is susceptible from that cause.

† A full explanation of this circumstance is given by Arago in the 'Annuaire du B. des Longitudes,' 1832.

their traditions from each other. Pliny abounds with rules for the government of agricultural operations by observations of the moon's phases, such as were no doubt strictly adhered to by the most skilful husbandmen of his day. In France the opinion formerly prevailed, as recorded by Pliny, that trees should be felled only in the wane; and the old ordonnances forestières enjoined this accordingly. In Demerara and some of the West India islands, Mr. Montgomery Martin states that there are woods which, if cut down during the increase, can be easily split and soon rot; but if cut in the wane, can with difficulty be riven and are extremely enduring; and the same was stated respecting the Brazils to M. A. St. Hilaire, of the French Academy, from whom M. Arago derived his information.

These remarks have already trespassed too much on the space due to more interesting matter in the pages of this Journal.

M. Gasparin's three volumes, while they add considerably to the stock of our general knowledge in husbandry, confer additional importance upon it by their suggestive and enquiring character. The comparison, of course, real or supposed, either in meteorology, physiological chemistry, or any other department of practical agriculture with the results attributed to them, will, in the end, increase our own experience: and while it promotes a habit of investigation among agriculturists, it will eventually transfer many of the unexplained phenomena of nature and cultivation from the region of mere inductive reasoning into the domain of recorded truth.

*Ashley Combe, Somerset, Sept. 29th.*

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## XVI.—*Practical Experiments on the Air-drainage of Land.* By Simon Hutchinson, Land-Agent.

On the 10th of February, 1846, I recommended to Lord Brownlow's tenants in a pamphlet the construction of air-drains, or connecting head-drains, in addition to the ordinary parallel drains—a practice at that time *entirely new* to the public.

Experience having confirmed my opinions as to the advantages of this practice, it may not be uninteresting to state the result of one of the many successful experiments I have made to test its practical utility.

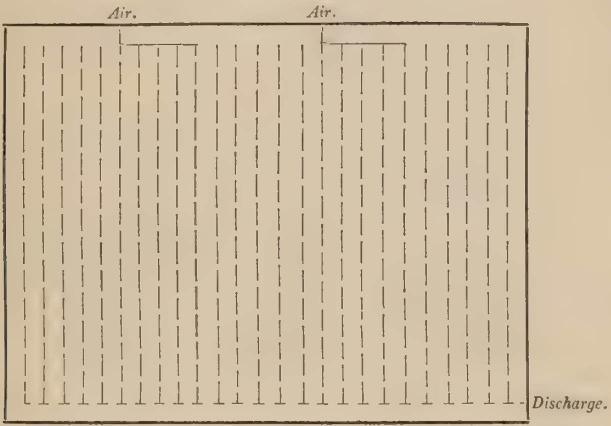
The field to which I shall refer is in the occupation of Mr. Stafford, of Marnham, near Newark on Trent, and consists of ten acres of strong loamy soil, upon a clay subsoil. It was underdrained by Mr. Stafford in 1843 by twenty-five parallel drains,

two feet deep and five yards apart, each discharging into a covered outfall at the bottom of the field.

In the autumn of 1846 it occurred to me that this, being a shallow-drained field, presented a good opportunity for experiment; I divided it into five compartments, each containing five of the drains. With the two outside and centre compartments I did not interfere. Into the two other compartments I introduced what I call an air-drain across the *upper ends* of the five drains in each case, to join them together. I then connected the air-drain so cut with the adjacent open ditch at the top of the field, in order to increase the natural current or circulation of air through the ordinary drains.

The following diagram may serve better to illustrate my case :—

*The black lines represent the Fences; the dotted lines the Drains; the complete lines the Air-drains.*




The field was afterwards cultivated in the usual manner for turnips, and I did not again visit it until Wednesday the 19th of May, 1847, the very heavy rains of the winter and spring having concluded late the previous evening by a pouring rain of four hours' duration; Mr. Stafford and I on this day traversed the field in all directions, and the superior condition of the soil on the two *air-drained* pieces was everywhere distinctly apparent; but what afforded proof more convincing and undeniable was the circumstance that, on ploughing the field *across* all the drains, on the following morning (Thursday), wet bright marks were left by the plough on the land within the two outside and the centre compartments, but no indications of wetness appeared on the two *air-drained* pieces.

We together again visited the field on the following 4th of August, when we found the turnips, owing to the intervening and

*uninterruptedly* dry weather, by no means flourishing; yet it was peculiarly gratifying to find the turnips on the *air-drained* land certainly one-half superior to those on the remainder of the field.

Very soon after this latter date frequent and copious falls of rain ensued, and in consequence the turnips on the non-air-drained land improved proportionately more than those on the air-drained, showing that the damp air at nights, &c. &c., had all along supplied moisture to the latter to a considerable extent.

As wheat seed-time approached the whole field of turnips was condemned as being too inferior to stand through the winter; therefore, it was at once determined to clear the ground and sow wheat, which, in each successive stage towards maturity, clearly showed, as in the case of the turnips and numerous other experiments under observation, most prosperous on the air-drained land.

In order to test the accuracy of our observations, the produce of the turnips and the wheat, in portions of nearly an acre in each of the several divisions, was carefully weighed, the result being as follows, viz. :—

| DESCRIPTION. | Produce per Imperial Acre. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turnips. | | | | Wheat. | | | | Wheat Straw. | | |
| | Skirvings. | | Pine-ap. | | Weight. | | Measure. | | | | |
| | tons | cwt. | tons | cwt. | st. | lbs. | bush. | pks. | cwt. | qrs. | lbs. |
| Air-drained Land,—two sorts of turnips *drawn off*, succeeded by wheat . . . | 16 | 4 | 10 | 8 | 129 | 4 | 28 | 3 | 27 | 2 | 20 |
| Non Air-drained Land,—ditto ditto. . . | 13 | 12 | 6 | 16 | 94 | 4 | 21 | 0 | 20 | 2 | 24 |
| Difference per Imperial Acre in favour of Air-drained Land. . . . . . . . | 2 | 12 | 3 | 12 | 35 | 0 | 7 | 3 | 6 | 3 | 24 |
| *The result of another experiment proved as follows, viz :—* | | | | | | | | | | | |
| Air-drained Land,—Potatoes *ploughed up*, succeeded by wheat . . . . . . | . . | | . . | | 158 | 8 | 35 | 0 | 35 | 3 | 16 |
| Non-Air-drained Land,—ditto ditto. . . | . . | | . . | | 134 | 4 | 29 | 3 | 30 | 0 | 10 |
| Difference per Imperial Acre in favour of Air-drained Land. . . . . . . | . . | | . . | | 24 | 4 | 5 | 1 | 5 | 3 | 6 |

The quality of the wheat on the *air-drained* land was, in addition, judged to be superior by 3*d*. per bushel; and the straw of a brighter and better description.

The general produce, I am very confident, would have been much larger had the drains been deeper.

Mr. Stafford informs me (what I constantly witness myself in other cases) that, during windy or breezy weather, a draught of air through the drains is always perceptible at the outlets; and at other times, after water has ceased to be discharged, a hazy *evaporation* is frequently visible.

The conclusion to which my mind has been brought by this

and similar experiments is, that drains two feet deep, even at five yards apart, with air-drains to facilitate evaporation, &c., are *not* of sufficient *depth* to secure good drainage, yet I am quite conviced that they are more than equal to drains two feet six inches deep without such auxiliaries. Thus, by the simple and inexpensive plan of introducing my air-drains into lands drained by *present* insufficiently deep drains, the superior advantages of deeper drainage are, as has been shown, in some degree acquired.

*Manthorpe Lodge, Grantham, Lincolnshire,*
*30th September,* 1848.

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## XVII.—*Pleuro-Pneumonia among Cattle.* By GEORGE WATERS, Jun., M.R. Coll. Vet. Surg. Corn Exchange Hill, Cambridge.

### PRIZE ESSAY.

THE present epizootic disease, designated "Pleuro-pneumonia" from *πλευρα*, the side, or membrane enveloping the lungs, and *πνευμων*, the lungs, from its being confined principally to those parts—first appeared in this country about the year 1841—previous to which period it had existed and committed great ravages among the cattle in Ireland, and on the continent—and in England a very great proportion of the whole number of cattle which have been affected have died.

It is a rare thing for any epizootic disease to rage alone—that is, without being preceded or followed by some other. It will be remembered that the vesicular epizootic, which first appeared here about the year 1839, was the forerunner, and is to this day the companion of the present pleuro-pulmonic disease; but the ultimate consequences of each disorder differ as widely as they do in character. The vesicular epizootic, on the one hand, spared but few animals from its attack, and was seldom if ever fatal; whereas on the other, the disease in question affects few in comparison, but those in so dangerous a manner that but a very small proportion of those affected recover.

I shall first attempt a description of the disease, treating slightly the premonitory symptoms—mentioning those only which may be referred to the organs of respiration more especially. I am induced to do this, because I shall have occasion, in following out the order proposed by the committee of the Royal Agricultural Society of England with reference to several points connected with the disease, to treat of the "premonitory symptoms" at greater length.

The first and most constant symptom of this disorder is a cough of a dry or husky character, which may continue for a greater or less period before other symptoms of a more decided nature present themselves. The frequency and severity of this cough may be influenced by circumstances: for instance, I have observed when the animal is fed exclusively upon hay, straw, &c., or when it is lodged in a close ill-ventilated hovel, or turned into a low, damp, marshy spot, the cough has become aggravated, and other symptoms of the disease have more speedily presented themselves. Again the age and condition of the animal appear to govern its duration in this stage of the disorder: I have observed it, in young and well conditioned animals, to continue longer than in those which are old and emaciated.

I will now inquire what modifications of the healthy sounds may be detected in the chest in this stage of the malady. In the majority of instances no morbid sounds have been discovered; but I have occasionally found a crepitation or rattling along the upper borders and bases of the lungs. In some cases the animal has been noticed to cough up now and then, and discharge by the mouth, a thick mucous secretion.

I consider that the occurrence of this cough is an index to the commencement of a mild character of bronchitis, and which may exist for some time previous to the lung or pleura becoming diseased. Those symptoms which generally exhibit themselves at the time when the services of the veterinary surgeon are usually required, and which I consider indicate the second stage of the disease, are the following; for the better description of which I will instance a milch-cow. If in a meadow with others, she is observed to separate herself from her companions and to be generally lying down whilst the others are feeding, with an aspect spiritless and haggard, staring coat, surface of skin rigid, and almost immoveable over the ribs, increased temperature of horns, muzzle dry, back somewhat raised, head projected forwards and inclined downwards, impaired appetite, and rumination partially or totally suspended; pulse increased in frequency and oppressed, pressure on ribs and spine produce flinching, respiration quickened, and accompanied by a peculiar grunting and grating of teeth; which symptoms of pain are aggravated upon coughing, as also upon any alteration of the position of the animal; decreased secretion of milk with alteration of colour, being usually of a yellowish cast; it sometimes coagulates when boiled; tenderness of udder and teats upon being milked; bowels costive, and, when moved, the fæces are hard and lumpy; urine scanty and paler than natural; cough short and frequent, and increased upon exertion.

Upon applying the ear gently to the sides of the chest, so as not to frighten the animal, one or other is found to be affected,

and the right much more frequently than the left—sometimes, though rarely, both are implicated—but whichever lung be affected, the respiratory murmur in the other becomes louder and coarser than usual; the sound on percussion is natural.

On the affected side, if the pleura should be inflamed coincident with the lung or a portion of it, a peculiar crackling or fine crepitus is audible; this is limited to a small space in the beginning; but as the disease advances it becomes more diffused: this crepitus at first may be mingled with the ordinary respiratory murmur, which it nearly obscures; as the inflammation advances, it becomes more and more decided, until at length no respiratory murmur whatever can be heard throughout the part or parts occupied by the crackling. As the morbid action proceeds, the crepitus gradually disappears, giving place to other sounds: one of a puffing or blowing description may be heard during inspiration, as if confined to the bronchial tubes, and when the animal grunts or coughs the sound is conveyed directly to the ear. These sounds are most distinctly heard when the inflammation is confined to the upper and anterior parts of the lung, and when no effusion has taken place into the cavity of the pleura.

At the same time, and in variable spots, another symptom presents itself to the ear, viz., that of friction or rather creaking: this sound may be heard both on inspiration and expiration, but is more pronounced during the former; it is very inconstant, both as regards its duration and locality; for instance, we have heard it most distinctly in one particular spot one day, when no trace of it could be detected in the same place on the following.

On striking the affected side at this stage of the complaint a dull sound is usually elicited to a greater or less extent; but this will depend upon the amount of lung that has become inflamed, and the presence or absence of fluid in the chest.

These sounds offer various modifications accordingly as the pleura or substance of the lung itself is most inflamed; thus, if pneumonia predominates, the creaking is but slightly if at all heard, and the dulness on percussion is not so flat and general; while, if a larger proportionate amount of pleurisy exists, bronchial respiration, bronchophony, and the rubbing sound may be heard, while little or no crepitation is audible; a marked difference is also observed on percussion, the dulness is more defined and dead, and principally confined to the lower parts of the chest owing to the presence of fluid, which, in all cases we have examined, has become rapidly and abundantly effused when much pleurisy existed.

Should the animal survive this state, which it seldom does, the third and last stage of the disorder now rapidly sets in, and we may be certain of its existence when we observe a death-like

appearance in the aspect of the animal; the surface of the skin becomes cold and moist; coldness of horns, ears, and extremities; head still projected, with nose thrust into a corner, if in a hovel or stall; extreme restlessness; while she stands, which she frequently does, her fore-legs are placed wide apart, while her hind-legs are crossed one over the other; she is heedless of the approach of any one; respiration is rapid and intensely laborious; fœtid breath; there is a dirty-coloured viscid fluid occasionally mixed with purulent looking matter, discharged from the mouth; no secretion of milk; pulse rapid and weak, sometimes intermittent; extreme emaciation and prostration of strength, with inability to cough or swallow. In the majority of cases no sound whatever is heard on the diseased side, except a loud gurgling, which is audible at some distance; general dulness on percussion. This condition may continue for a few days, when she becomes reduced to a mere skeleton; at last her groans grow louder and more frequent; she makes ineffectual efforts to breathe from apparent suffocation; total insensibility sets in, which is quickly followed by death.

## *Morbid Anatomy.*

As we consider that the pathological history of this disease would be imperfect if it were not accompanied by a description of those appearances which the lungs of animals affected with it present after death, we shall next bring forward what has fallen under our observation in that respect; but in so doing, we feel it right, as a matter of justice to others, to state, that we are indebted to Mr. J. L. Bailey, Surgeon of Cambridge, not only for the assistance he has lent us in preparing this report—and especially for the drawings which accompany it—but also for having enabled us to interest Dr. Fisher, Downing Professor of Medicine of the same place, in this particular branch of our pursuit, who for many years has devoted much attention to the anatomical condition of diseased lungs in the human subject. Indeed we owe partly to the latter the description of the particular cases we are about to give, and almost entirely to him the general conclusions drawn from the conditions they offer.

The first description of morbid appearances that we shall give was taken from one of the animals referred to in *Case* 33. The disease had reached about its middle stage, and seeing no probability of saving the animal, we recommended it to be slaughtered. On examining the body we found the abdominal viscera quite healthy and the pericardium and heart in the same state. The left side of the chest was also healthy.

The costal pleura of the right side was coated throughout its whole extent with thick tough layers of coagulated lymph, placed

one upon another, but which could be easily separated from the subjacent pleura. The thickening was greatest at the anterior and middle part of the cavity. Posteriorly and inferiorly strong and extensive adhesions existed between the lung and the sides of the chest. The cavity of the latter contained about a gallon of light-sanguinolent fluid, in which masses of coagulable lymph, resembling lumps of fat, were observed.

The right lung was enormously enlarged, and its pleura exhibited a ragged appearance, being covered, like the costal pleura, with thick layers of lymph, and presenting here and there large patches of a brownish colour, which gave it a mottled appearance. Those variations of colour were particularly marked along the lateral portions of the middle and posterior lobes, and the layers of coagulated lymph were not so easily separated from those as from the other parts of the lung. The pleura, when divested of those accidental exudations, presented in places numerous large and injected vessels.

On making incisions into various parts of the lung, the pleura was found to be in many places considerably thickened—the portion covering the upper surface of the anterior lobe measuring at its greatest depth nearly three-eighths of an inch—that corresponding to the upper borders of the middle and posterior lobes being at least half an inch in thickness. The latter portion of the pleura, however, became gradually thinner as it approached the inferior or free edge of the lung, where its greatest thickness did not exceed one-tenth of an inch. On removing the external layers of lymph from the thickest part of the pleura, the latter retained a considerable thickness, see fig. 1 (*b*), arising from the

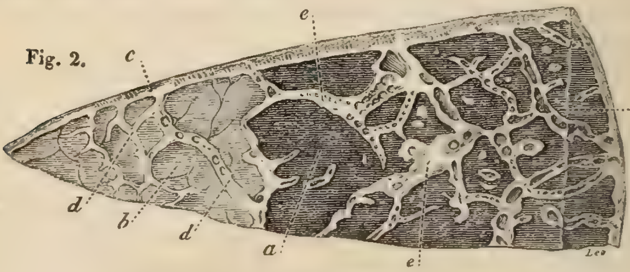
Fig. 1.


*a.* Thickened pleura.
*b.* Thickened sub-pleural tissue.
*c.* Thickened inter-lobular tissue filled with cells.
*d.* Hepatized structure of the lung studded with grey spots.

state of the subserous cellular tissue ; the appearance of which differed from that of the external coagulated lymph, inasmuch as it was firm, and contained cells filled with a grey semi-gelatinous fluid. The parenchyma of the middle lobe of the diseased lung when cut into, exhibited a surface of dark red and indurated pulmonary tissue, interspersed with grey points, and intersected by septa of a yellowish-white structure, which contained a great number of cells similar to those described already in the thickened subserous cellular tissue with which the septa communicated. See fig. 1 (*d*).

In another of the animals referred to in *Case* 33, and which was slaughtered at an early period of the disease, we found the right lung generally affected, but in a less degree than in the preceding case. We give in fig. 2 a drawing of a section of the anterior

**Fig. 2.**




*a.* Indurated pulmonary tissue.
*b.* Pulmonary tissue, nearly natural.
*c.* The thickened pleura.
*d.* Interlobular cellular tissue of more healthy portion of lung.
*e.* Thickened interlobular cellular tissue.

lobe in this instance. We have represented at letter (*a*) an indurated state of the pulmonary tissue, of a bright red colour, and intercepted by thick septa; at letter (*b*) we have a portion of the lung near its apex, presenting almost a natural appearance as regards its tissue, but an anormal one as regards its subpleural (*c*) and interlobular cellular tissue (*d*).

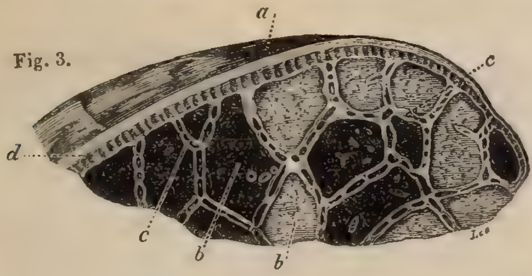
The following is a description of the lung of one of the animals mentioned in *Case* 18 :—

The two lungs were partially affected, but the left more so than the right. On examining the former from before backwards, *i.e.* from the apex of the lung towards its base, and along its upper or costal surface, the anterior lobe was found to be free from disease, both as regarded its pleura and parenchyma, but a little beyond the anterior end of the posterior lobe, and especially in that part of it corresponding to the space between the angles of the ribs and the spine, the pleura became covered with a layer of coagulable lymph, whilst the lung beneath was swollen and

indurated; but as we proceeded backwards, or to the base of the lung, the layer of coagulated lymph on the surface of the pleura gradually disappeared, and the latter presented at last only a slightly-thickened white and opaque aspect, the part of the lung underneath being somewhat infiltrated with fluid, but not hepatized, for it swam in water. In passing from the spinal edge of the middle part of the posterior lobe towards its middle or free edge, we found that the diseased conditions both of the pleura and the lung gradually diminished, and that the latter assumed a healthy appearance when within three inches of the edge.

A vertical incision was made in a part of the diseased portion of the lung from the pleura, of which the coagulated lymph had been scraped—the surface exhibited, as in the previous cases, a thickened state of the sub-pleural cellular tissue: the parenchyma of the lung itself was red and hepatized, and was intersected by septa, apparently resulting from the solidified state of the interlobular cellular tissue. The pulmonary lobules, or spaces comprised within the septa, did not present an uniform aspect, some being of a bright, others of a brown or black-red colour; this appearance is represented in fig. 3 (*b, b*). The anterior lobe of

Fig. 3.




*a.* Lymph covering pleura.
*b.* Hepatized substance of lung, varying in colour and consistency.
*c.* Thickened septa.
*d.* Thickened pleura. The dots point to the pleura itself lying between the external layers of lymph, and thickened subserous cellular tissue.

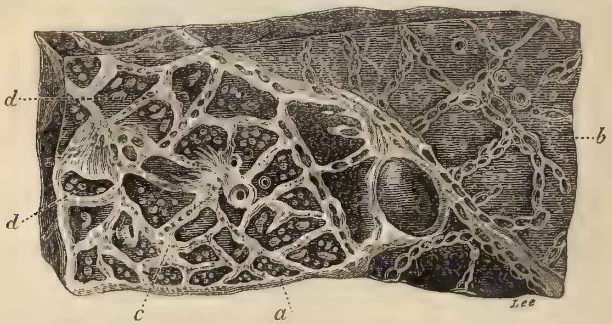
the right lung appeared quite healthy; such was not the case with the middle lobe; the pleura and parenchyma of which were diseased for about three inches from its spinal to its sternal edge, but, as we approached the latter, the pleura continued to exhibit a certain degree of thickening and opacity, whilst the corresponding portion of the lung gradually assumed a healthy aspect; a piece of its free edge, though covered with diseased pleura, swam in water. The anterior part of the posterior lobe was slightly indurated, and strong adhesions existed between it and the middle lobe; the remaining part of the posterior lobe, *i. e.* the base of

the lung, presented a healthy appearance. The mucous membrane of the bronchial tubes offered a bluish-like redness, which became more marked in those situated in the diseased portion of the lung—indeed the latter contained some muco-purulent matter.

Morbid appearances met with in one of the cows alluded to in *Case* 15:—

The left cavity of the thorax contained a considerable portion of fluid, and its pleura exhibited extensive indications of disease; the lung of the same side, and more especially the posterior lobe, from its base forwards, offered an immense volume, which contrasted strongly with that of the right lung, which was not diseased. The pleura of the posterior lobe was covered more or less with coagulated lymph, and was thickened and opaque throughout; the anterior lobe of the same lung did not appear to be enlarged, at least when compared with the posterior lobe, but presented, on the contrary, a collapsed appearance. Nevertheless its pleura was the seat of thicker, rougher, and denser exudations than that of the posterior lobe. An incision made through a part in the posterior lobe, exhibited a surface analogous to that of which fig. 1 offers a representation, but a section of it removed from near the base showed a different aspect, as represented by fig. 4. In this

Fig. 4.




*a.* Pleura slightly thickened.
*b.* Hepatized pulmonary tissue, of a brownish-red colour.
*c.* Thickened septa, of a whitish colour.
*d.* Hepatized pulmonary tissue, of a greyish-red colour, interspersed with light-grey spots.

the lobules, in one part, as well as the intervening cellular tissue, were of a deep brownish red colour (*b*), in another the septa (*c*) were very thick, of a whitish colour, and the intervening tissue of a greyish brown colour (*d*), interspersed with white dots. The anterior lobe of the same lung was the seat of a morbid product, different from that which is ordinarily considered the result of inflammation: it occupied the lobules of the lungs, was of a solid structure, and of a whitish colour, and surrounded by pulmonary

tissue, which seemed rather to be infiltrated with fluid than hepatized by inflammation.

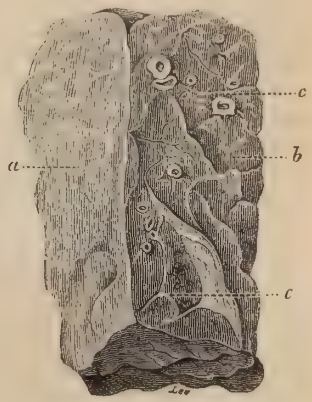
The right lung was apparently healthy, the pleura was not only free from exudations, but exhibited no traces of thickening or opacity: but in the middle of the anterior lobe there was a morbid product, similar to that we had met with in the other lung: it was about the size of a split walnut, and was immediately surrounded by healthy lung, even the pleura covering its surface was so transparent, that vessels could be seen ramifying in the tissue that separated it from the pleura. We stated before that the right lung was apparently healthy, nevertheless a number of air-bubbles might be observed beneath the pleura, fig. 5 (*b*), and

Fig. 5.


Portion of emphysematous Lung.

*a.* Pulmonary tissue, slightly injected.
*b.* Pleural surface, showing emphysematous bubbles beneath.
*c.* Interlobular spaces enlarged by emphysema.

Fig. 6.




Portion of healthy Lung.

*a.* Pleura.
*b.* Pulmonary tissue.
*c.* Interlobular spaces.

also in the inter-lobular cellular tissue (*c*). The parenchyma of the whole lung represented the appearance designated "vesicular emphysema," a state in all probability due to the increased functional work it had to perform, in consequence of the general impermeability of the left lung to air. In order to convey better an idea of the changes which the lungs undergo in this disease, we have thought proper to add a drawing of a portion of the healthy lung of a bullock, see fig. 6; (*a*) represents the serous or pleural, (*b*) the incised surface, (*c*) the interlobular spaces.

In the descriptions just given, allusion to the state of the mucous membrane of the bronchial tubes is only made in fig. 3, and in

that instance it exhibited but slight traces of disease. I have, however, had opportunities of examining numerous animals which had been slaughtered during the first stage of the disorder. In several, the lining membrane of the bronchial tubes presented in many places patches of a reddish or brownish colour, without any apparent thickening; but what appeared to us remarkable, was a firm, whitish substance, resembling coagulated blood deprived of its colouring matter, which occupied several of the smaller bronchial tubes, to which they were perfectly moulded. The pulmonary tissue was quite healthy. We may also add that we have met with similar appearances in lungs still further advanced in the disease.

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I shall next bring forward some general considerations on the morbid appearances described in the foregoing cases.

The inflammation of the pleura leads to an exudation of fluid, one part of which settles to the lower part of the chest, in a liquid form, more or less sanguinolent and ropy; another adheres to the side of the pleura, and forms layers, to which the term coagulable lymph is applied—in some instances those exudations lead to adhesions between contiguous pleuræ.

The effusion of fluid in the cavity of the chest must interfere with the conditions of the lung, especially if the latter be in a healthy state, in that case it will become compressed; but if the lung be inflamed, then the degree of firmness, as well as volume which it acquires, enables it to resist the pressure of the fluid, so that the presence of the latter in large quantities must then lead to the dilatation of the sides of the chest. The cases described justify the supposition that the pleura is liable to be affected earlier than the lung. Thus, in the third case, the pleura of the posterior lobe was opaque and thickened as far as its base, whilst the corresponding parenchyma of the lung exhibited few, if any, signs of disease; a similar state existed on the opposite side, in which the pleura and lungs were both diseased at the spinal edge of the middle lobe, whilst at its free edge the pleura only was affected.

The tendency on the part of the pleura to be first affected is not without practical importance. Commencing pleurisy may furnish the first untoward symptoms, and indicate the propriety of active treatment, to which the disease will at that period in all probability be amenable.

The appearance which the sub-pleural cellular tissue presents in this disease is not without interest. It differs from the layers

of coagulated lymph adhering to the outer surface of the pleura, inasmuch as it is firm, indurated, and more or less beset with cells. In that respect it closely resembles the interlobular cellular tissue, and ought to be considered in association with the diseased state of the lung; but that it may be partly the means of communicating the inflammation of the pleura to the lung is a consideration not to be overlooked.

The changes which occur in the parenchyma of the lung in this disease may be considered in reference to two tissues, the one the vesicular or proper structure of the lung—the other the intervening cellular tissue, diffused through it in areolar webs, and separating the pulmonary tissue into lobules; hence it may be termed interlobular areolar tissue. It will simplify the study of the effects of this disease to consider the latter first, and if we refer to fig. 6, which represents a piece of healthy lung, we shall find the interlobular tissue (*c*) but indistinctly marked; but if we pass to fig. 5, which is a drawing of a piece of lung affected with emphysema, we may perceive that this interlobular cellular tissue is dilated by air (*b* and *c*), but still retaining its areolar, glistening, and semi-transparent character. If we pass to fig. 2 (*d*), we shall find this offering a white or yellow colour, and assuming a firmer structure, interspered with small cavities: that interlobular tissue, however, is seated amidst nearly healthy lung; but in the same drawing we may observe at letter (*a*) the pulmonary tissue in apparently the first stage of inflammation, and in that part the interlobular cellular tissue (*e*) presents a degree of thickness much greater than what it did in the healthy portion. But if we next proceed to fig. 1 (*c*), or fig. 4 (*c*), we find this interlobular cellular tissue offering such a degree of thickness, as to give it the appearance of entering in a large proportion into the structure of the lung itself, and its continuity with the subpleural cellular tissue is such as to warrant the conclusion that they are identical in character.

Whatever may be the form of the pulmonary cells and their relative arrangement, it is quite evident that in that stage of inflammation called hepatization, those cells become obliterated. This obliteration is due, in our opinion, to a change which has taken place in the walls of those cells which have become thickened, through an addition of organic matter, in the same manner as the inter-lobular cellular tissue had become increased in volume.

A question has been mooted whether the tissue of the lung swells in inflammation, seeing that its volume is limited to the capacity of the thorax, but the swelling takes place inwards, *i. e.* the walls of the cells, by increasing in thickness, obliterate the

latter. As the middle lobe of the right, and the anterior part of the posterior lobe of the left lung are the parts which the inflammation seems usually to affect first, it would be advisable, when examining the chest of an animal, to direct our attention to the middle part of the back in the region corresponding to the angles of the ribs.

In the last case described (15.), a morbid product was found not only in the anterior lobe of the lung affected with the disease, but also in that of the healthy or rather emphysematous lung; this product presented all the characters of the tubercle. Now without saying that the constitution, which is favourable to the development of tubercles, may not be a predisposing cause of the disease in question, yet it is evident that the presence of tubercles in the lung, at least in their first stages, does not render the parts around them more liable to inflammation than other parts of the lung, a fact not without importance as regards the general history of the tubercle.

Having concluded the principal matter that I have to communicate on those parts of the history of the disease which have reference to its symptoms and to morbid appearances after death, we think it better, before we take up the several heads under which the society has expressed a wish that it should be considered, to bring forward, as concisely as possible, cases which have fallen under our observation, and from which the opinions we shall have occasion to express when treating of those heads, will be chiefly drawn.

*Case* 1.—Mr. S., in October, 1841, bought twenty bullocks at Peterborough Fair, six of which were subsequently attacked with pleuro-pneumonia at different periods, varying from one to three weeks, after their arrival upon the premises. They were all observed to husk soon after being purchased; but this was considered by the owner of no importance.

*Case* 2.—In 1842 Mr. V. bought thirty-five Irish heifers at a large stock-market in the neighbourhood, most of which were shortly after attacked with disease of the lungs; three died within a fortnight; several others were afterwards disposed of whilst in pretty good condition, and on being opened their lungs exhibited appearances of the disease.

*Case* 3.—A cow belonging to a poor man of this town, Cambridge, fell ill on October 13, 1844, of pleuro-pneumonia, and after undergoing treatment for ten days, died. This cow was purchased a short time previously at St. Ives' market.

*Case* 4.—Mr. H. bought thirty head of stock at Stamford Fair, on November 18, 1844. They were driven home to a distance of about thirty miles; shortly after they were all observed to cough, some more so than others. Three died.

*Case* 5.—Mr. F., a gentleman who grazes a considerable number of cattle, purchased in the autumn of 1844 a herd of three-year-old steers at a fair in the north of England: several of them were observed to husk at the time, and died soon after. This was the first appearance of the disease on this gentleman's farm; and for the succeeding two years the loss amongst his cattle from the same cause has been immense.

*Case* 6.—About the middle of July, 1846, Mr. J. purchased ten heifers at St. Ives' market: all coughed, and four died of the disease shortly afterwards.

*Case* 7.—In the same month and year, Mr. I. bought twenty cows at a fair, eight of which were attacked with the disease soon after, and died.

*Case* 8.—Mr. S. lost three cows out of ten, bought at the same place, and about the same period, as the former.

*Case* 9.—Mr. P. bought in the beginning of November, 1846, six heifers at a market close by. Two were immediately observed to be affected with the epizootic pleuro-pneumonia, and both died within a fortnight after being purchased.

*Case* 10.—Mr. D. bought in November, 1847, twelve steers at Bury market, all husked at the time. One died on December 2nd of the disorder; and several of the others, looking thin and weak, were sent back again on the 21st to the same place to be sold: they were afterwards traced to the person who had bought them, and three more were ascertained to have died.

*Case* 11.—In March, 1843, Mr. S. requested my attendance upon a calf six months old, that was labouring under the disease, he having previously lost twenty-three by the epizootic pleuro-pneumonia. The disease on this farm originated in some cattle purchased at Peterborough fair, and spread so rapidly that this gentleman was obliged to sell all the remainder of his stock, fearing he should lose a great many more. The average quantity kept was from eighty to an hundred.

*Case* 12.—Mr. W., dairyman of this town, Cambridge, who keeps on an average twelve cows, lost two during the spring of 1845, and six more during the latter end of the same year and commencement of the following.

*Case* 13.—Mr. A., a dairyman of the same place, kept up a dairy of ten cows during the period between June and December of 1846. Four died; and several others, which were afterwards attacked with the disease, were disposed of, and fresh ones bought in, to keep up his usual number. This person has generally been in the habit of supplying any deficiency in his usual number from dealers.

*Case* 14.—Mr. M., between November 13, 1846, and February 15, 1847, had three steers and two cows attacked with pleuro-pneumonia, out of a stock of twelve steers and six cows. One of the steers and both cows died. The twelve steers had been purchased at a market

some short time before, and were turned into the same yard with the six cows.

*Case* 15.—Mr. S., a farmer, in October, 1847, bought two cows, one of a cattle-dealer close by, and the other at St. Ives' market; shortly after this he allowed a friend to turn two buds (recently bought out of a drove) into the same pasture with them; the buds were observed to have a cough from the first, and about a fortnight after one died of pleuro-pneumonia. The cow bought of the dealer soon after died of the same disease. And on the 9th of January, 1848, the other cow was taken, and died on the 28th of the same month.

*Case* 16.—Mr. S. purchased in 1845 ten head of stock at a fair; all were observed to cough or husk more or less; shortly afterwards six became decidedly affected with the disease, and five died. This is a very healthy and well conducted farm, containing on an average from twenty to thirty head of cattle.

*Case* 17.—In September, 1844, Mr. F. summoned us to attend some young home-bred stock, which he had reason to think were suffering from the epizootic pleuro-pneumonia. They were confined in a close and ill-ventilated hovel. All recovered. The manner in which they first became affected is not known.

*Case* 18.—In March, 1844, Mr. F., milkman of Cambridge, had nine cows, and in the same month they were all observed to have a cough, and one, which eight months before he had purchased of a neighbour, became attacked with the disease, and thinking it to be the "garget," waited three days before we were called in. She was attended for three weeks and died. About a fortnight before Christmas in the same year, he bought another cow of a jobber of St. Ives' market, which also died of the same disease in six weeks. A few days after this he bought two more at Bury market; one was taken, and died in three weeks, and the other within a month. He then purchased two more cows of a person about a quarter of a mile distant, and fearing if these were taken home they might catch the disease, he requested that he might milk and graze them on the person's premises, which had hitherto escaped the malady. This was readily granted; but they, too, became affected with the disorder and died, after being treated for about a fortnight. Several others on the same premises were immediately attacked; some died, and some were slaughtered. Between this period and January, 1848, eight more have died of the same disorder. Mr. Fletcher's premises stand in a low and confined locality, and until very recently had never been drained.

*Case* 19.—In the latter end of August, 1846, Mr. W., who farms between four and five hundred acres of land in a low marshy district, situate on the banks of the Cam, purchased nine steers at an extensive stock-market in the neighbourhood, all of which were observed to cough shortly afterwards. He kept them for about a month, and perceiving no improvement, exchanged them for nine heifers with the same dealer. These were also noticed to cough in a few days; and on the 12th of October one of them died of confirmed pleuro-pneumonia.

All the remainder were more or less affected; and after having been removed into a warm yard and undergone treatment, recovered, with the exception of one, which lingered for some time, and ultimately died a mere skeleton. Four milch cows on the same farm were carefully kept apart from the young stock, and escaped the malady.

*Case* 20.—Mr. F. during the years 1845 and 1846 sustained a loss of nearly one thousand pounds' worth of stock from the epizootic pleuro-pneumonia. Those that were in tolerable condition were disposed of, and slaughtered immediately on the first decisive symptoms of the disease presenting themselves, thus affording us many opportunities of observing the state of the lungs in this earlier stage of the disease. Nothing satisfactory could be obtained as to the origin of the disease on this gentleman's farm.

*Case* 21.—Mrs. R., cowkeeper of Cambridge, who keeps ten cows, lost three out of four which were attacked at various periods between May 4 and July 21, 1847, with pleuro-pneumonia. The disease in this instance was supposed to have arisen spontaneously.

*Case* 22.—Mr. T., a large farmer, purchased about the middle of 1844 nine heifers of a dealer, one of which was shortly afterwards attacked with the disease, and after being attended for some time became considerably reduced, and was sold. The remaining eight were disposed of to a dealer just previous to the before-mentioned one becoming affected, four of which were ascertained to have died shortly after. This was the commencement of the disorder upon this farm, and has since made great havoc amongst the cattle. Mr. Toller generally keeps from eighty to an hundred head of stock on the three farms of which he is proprietor, and during the last three years he has repeatedly been obliged to dispose of cows and young stock at a very great disadvantage, on account of their becoming diseased. The farms are all contiguous, so that the cattle have free communication with each other. Several were also affected with the vesicular epizootic at the same time, and recovered.

*Case* 23.—Mr. S. bought forty Irish beasts on December 3, 1846, at a market. Soon after they all became affected with the vesicular disease, and recovered, except four, which were attacked with pleuro-pneumonia. Two were sold and slaughtered; the others recovered.

*Case* 24.—Mr. M., of Cambridge, purchased two heifers at St. Ives' market in the beginning of May, 1847, one of which was observed to cough at the time, and on the 18th of the same month was sold and slaughtered, after being treated for nearly a week. The other was attacked with the vesicular epizootic at the same time, and soon recovered.

*Case* 25.—In the month of November, 1841, Mr. J. purchased at Stamford fair fifty-eight head of Irish cattle, and soon after being brought home most of them were observed to have a dry husking cough; three upon examination were found to be suffering from decided disease of the chest, and died some short time after; and from the supposition that the remainder were labouring under the same disease,

but in an earlier stage, they were immediately bled and physicked, and finally recovered.

*Case* 26.—In the autumn of 1846, Mr. S. purchased twenty stores at a distant fair, all of which coughed; one died of pleuro-pneumonia; the others were bled and physicked, and recovered.

*Case* 27.—Mr. C., in the early part of November, 1846, purchased at St. Ives' market twenty steers; two were soon after attacked with pleuro-pneumonia, and died; after this several others were affected with the disease, and upon being bled and physicked, recovered.

*Case* 28.—Mr. S., a dairyman of Cambridge, who keeps thirty cows, lost during 1847, and the previous two years, twenty-seven cows and a bull in consequence of being attacked with the disease, since which time all his cows have been setoned, and no deaths have occurred.

*Case* 29.—Mr. J. purchased in the month of November, 1846, twenty Scotch beasts at Stamford fair. Soon after their arrival at home they were observed to cough, and were turned into a yard with five cows. Between this time and the middle of December of the same year seven of the young stock died; during which period the five cows became affected; three died; all the remainder, both cows and young stock, recovered after being bled, physicked, and setoned.

*Case* 30.—Mr. H., of Cambridge, on September 18, 1847, bought at the market in the same place, two buds out of a drove, which he turned into a paddock. On the following day both were observed to cough: one lived till the 30th, when it died; the other recovered under treatment.

*Case* 31.—Mr. C., of the same place, had four cows out of eight attacked with the same disease, between April 13 and July 28, 1847. Three were disposed of, and the other recovered under treatment.

*Case* 32.—Mr. R., of Cambridge, had five cows in July, 1846, when three became attacked with pleuro-pneumonia; two died, and the other recovered under treatment, but slipped calf shortly after, as did several others in the preceding cases.

*Case* 33.—Mr. F., of Cambridge, purchased at the latter end of October, 1847, four steers at St. Ives' market, which were noticed by the steward to husk from their first appearance on the premises; and on November 19, observing that one was ailing more than the rest, was treated for a few days without effect, and then sold. Between this period and January 3, 1848, two more were attacked in the same manner; one recovered, the other was disposed of.

### *Mode of Infection.*

Before stating my opinion on the "Mode of Infection," I shall take the liberty of bringing forward a few general considerations on the circumstances which appear to exercise an influence on the original production of a disorder, which, infectious though it

may be, comes nevertheless within that class of diseases termed Epizootic.

The subject of Epizootic diseases is one of an extensive range, and admits of a wide field for speculation; there are, however, some general as well as particular circumstances which we should not be justified in overlooking. The manner in which this, or diseases of a similar kind, are not only observed to prevail over extensive districts of the same country, but also in different countries themselves, would lead us to ascribe their origin, as well as their specific character, to peculiar atmospheric conditions; but as yet so little has been positively ascertained regarding those conditions, that whilst we are obliged to take them into account, whilst dealing with the general history of the disease, we are not able to draw any practical application from them. I may however mention that, unusual and irregular weather—the prevalence of particular winds—varieties of season, as drought and moisture, may exercise some influence on the development of the disease : but what is of more practical importance, that local conditions, either as regards situation of pasturage and quality of herbage—impurities of stabling—stall-food, either defective in quantity or quality, may also materially contribute to its production.

And in addition to the above mentioned external causes, I must not fail to call attention to those conditions in which foreign cattle are placed before they arrive in this country—such as a voyage by sea—confinement on deck, &c.; or the manner in which they or home-bred cattle are driven from one place to another, under which circumstances they are made to undergo much fatigue, and are generally obliged to pick up food by the roadside, or in limited pastures; being at the same time exposed to all varieties of the weather. However, many of the inconveniences connected with the forwarding of cattle from one place to another, are now obviated by the facilities afforded by railways.

If we take a general survey of the causes just brought forward, we shall find that they almost collectively lead us to the conclusion that the manner in which cattle are met with, congregated together at fairs, markets, or passed from place to place, favours, if not the production, yet in a most remarkable manner the dissemination of the disease.

It is true that we might at first sight ascribe the frequent occurrence of the disease in cattle so circumstanced to infection, but we must bear in mind that they have all been placed in the same conditions, and that there can be no more reason that one should escape the effects produced by such conditions than another. We must, however, give some restriction to the last expression, be-

cause it is probable that a particular animal, by virtue of its peculiar constitution, as well as its general health when brought amongst the stock, would be more liable to become affected by the conditions before mentioned, than the others; and moreover, we can conceive that an animal so disposed should take up the disease, and afterwards communicate it to others. But quitting the subject which bears on the dissemination of the disease amongst drifted cattle, we shall next take into consideration the manner in which we have observed it to break out most frequently in private establishments; and a reference to our cases in general, but to *Cases* 14, 15, 18, 22, and 29 in particular, will, we think, satisfactorily show that it is chiefly due to the introduction of drifted cattle to home-stock; and the fact, of the latter, which were previously in good health, becoming affected after being brought into communication with the drifted or diseased cattle, establishes in our mind the proof, that the disease is infectious. As regards the "mode of infection" itself, it is difficult to say whether immediate contact be necessary or not: but we can readily conceive the air itself to be a medium by which the disease may be communicated from one animal to another.

There is another point of view under which it would be well to consider this question—how far premises previously occupied by diseased animals, but from which they had been removed, may communicate the disorder to fresh comers? But this question can hardly be discussed apart, for it involves another consideration, that of the healthiness of the locality itself; and it may not unfrequently have happened that instances of disease successively occurring in different animals in the same locality may have been with less correctness ascribed to the influence of infection, than to the unhealthiness of the former: the losses which Mr. Fletcher experienced might with as much justice be referred to the general unhealthiness of the premises, as to the effects of infection. In some of the cases of disease which we have related, viz. 17, 20, 21, &c., the origin could not be traced to the effects of infection; and that circumstance adds to the importance we should attach to the conditions in which isolated animals are placed as regards their liability to disease.

To dwell longer on this head would expose us to repetition when we bring the next subject to be treated under consideration.

### *Precautions against Infection.*

Without discussing the point, whether the disease was introduced into this country by foreign cattle—or whether any system of police could have prevented that introduction—we must now, as regards precautions, consider the disease as it is met with in

this country. The facts I have brought forward tend to show that the disorder is principally propagated by fairs and markets; and I should recommend the buyer, whenever he is in doubt about any stock he is anxious to purchase, to consult those who are familiar with the premonitory symptoms of the disease. But if he should be so unfortunate as to purchase animals affected with the malady, or exhibit any tendency thereto, he would do well to first lodge them in a well-ventilated and warm building, apart from other stock; and, contrary to the plan usually adopted, the air should be accessible from the upper part more especially. Particular attention should also be paid to the diet, which should be of a light and nutritious character, such as boiled linseed, boiled turnips, carrots, bran-mashes, &c.; but upon no consideration should hay, straw, or dry chaff be given, which articles of food we have repeatedly observed to produce considerable irritation of the respiratory tract.

The importance of medical treatment in the first stage has been sufficiently pointed out to show that as little delay as possible should be had in having recourse to it. Those individuals who are in the habit of attending upon such cattle should wear a loose external garment during the time they remain with them, and should not be allowed to approach other stock without first taking it off. Although we have no proofs that the disease is communicable by contagion, yet the facts that have fallen under our observation warrant me in recommending this change of garment.

As regards precautions to be taken with healthy cattle, I should recommend all those causes I have particularly pointed out as predisposing, to be avoided, but especially confinement of numerous animals in ill-ventilated and narrow buildings, bad food, impure water, exposure to cold east winds, &c.

Buildings which have previously been occupied by diseased cattle should undergo as complete a purification as possible. They should be first washed with a strong ley of pearl-ash or soda, afterwards they may be tarred, and quick-lime scattered about the premises with water sprinkled upon it, if the place should be dry. But I feel I shall be guilty of a great omission if I did not impress upon the owners of cattle this additional precaution. They must not attach too much importance to disinfecting means: for cases which have fallen under my own observation, and Fletcher's more particularly, amply show that the locality of the stabling itself, its imperfect drainage, the conditions of ventilation, &c., may, I will not simply say keep up, but even give rise to the disease; and if this opinion be correct, it is quite evident that precautionary disinfecting means will prove of little or no avail.

So much with regard to external circumstances as precautionary

means; but the success which has attended the treatment we have adopted in healthy cattle themselves, that is, the application of a seton in the dew-lap, induces us to recommend its use in all cases when well-grounded apprehensions are entertained as regards the liability of cattle to the disease.

### *Premonitory Symptoms.*

It is rare that we are called in at the commencement of this disease, but when we do see animals in that stage, the following symptoms usually present themselves. The first and most important of these is a short husking cough, and to which I have so frequently alluded in former parts of this paper. This may continue for a variable period: sometimes it is observed to commence but a short time previous to the appearance of other symptoms of a less ambiguous nature, while in others it may hang upon the animal for some considerable time; soon after this cough has set in, a diminution of the natural secretions may be observed, and if a cow be the subject of the disorder, her milk becomes scanty, and sometimes slightly altered in colour; I have also found it to coagulate upon the application of heat. The breathing is natural while the animal remains tranquil, but upon exertion, such as when driven to a short distance, for instance, it becomes accelerated and laboured. Appetite not perceptibly impaired, although the animal looks somewhat lank; pulse regular, no appreciable alteration in the temperature of the animal; in some instances diarrhœa sets in spontaneously; in others there is constipation: with the exception of the above mentioned symptoms the animal appears tolerably healthy.

Although these symptoms may and do exist in most cases for a sufficient length of time to warn us of the approach of the succeeding active stage of the disease, yet from their comparatively mild and doubtful character they elude suspicion; consequently, if observed, they are either neglected, or considered of too little importance to require medical treatment.

This, which I have been in the habit of designating the husking stage, is the most important in a practical point of view; at least so far as regards the possibility of saving the life of the animal by treatment.

It is usual, after having described the symptoms of a disease through its different stages, to point out those which indicate a favourable result, but I have omitted doing so, because I felt that the danger an animal runs when affected with this disease would be better understood after the morbid conditions which characterize its different stages had been shown; and I have only to refer to those morbid conditions which we have described, and of which I have given illustrations, to show that the danger that the animal runs increases as the disease advances.

The course that I pursue when consulted about this disease is directed by two considerations: the one, that of saving the animal; the other, that of considering the interests of the proprietor. If I am called in during the first, or beginning of the second stage, I have recourse to a treatment which we shall shortly describe. But if the disease be so far advanced as to render the result of treatment very doubtful, I generally recommend the animal to be slaughtered, so as to expose the proprietor to the least possible loss. I do not wish it to be inferred from this practice that the disease in its second stage is necessarily incurable, for I have had some cases of recovery from it; but those instances are so few as scarcely to warrant one in running the risk of increasing deterioration in the value of the animal for the chances of recovery.

As regards treatment in the last stage, I consider the animal in so hopeless a condition that it is scarcely worth while having recourse to it, and I generally recommend it to be killed, in order to put an end to its sufferings.

That this report therefore may be of as much practical use as possible, we shall dwell at most length on the treatment of the first stage, not however omitting that of the second.

### *Treatment.*

If, on examination, we find that the animal has a cough, but no particular loss of appetite, no dryness of muzzle, and no heaving at the flank, the best plan is to apply counter-irritants, such as setoning, or pegging in the dew-lap: of the two, we prefer the latter, it having proved more effectual. The operations may be performed as follows: if a seton be employed, a large and sharp seton-needle should be used, armed with coarse filleting or a mixture of tow and horse-hair; each end must be tied into a large knot. The seton should be dressed once or twice a week with strong blistering ointment. For pegging, an incision is made on either side of the dew-lap with a pair of rowelling scissors, or scalpel, sufficiently large to admit the end of the fore-finger. The integuments are then separated from the cellular tissue beneath, between which parts two or three small pieces of the fresh root of Black Hellebore (Helleborus niger) are inserted, or in place of these a small portion of tow besmeared with blistering ointment, may be used. When the condition of the animal admits, an occasional purge of a ℔j or a ℔jss of Magnes. Sulph. should be given, combined with an aromatic, as ℥j of caraway or cumin seed powdered, to prevent any depressing effects that might attend its action.

But if, in addition to the cough, any symptoms of febrile disturbance should exist, such as unusual heat of the horns, dryness of the muzzle, accelerated pulse whether strong or oppressed,

costiveness, or any of the symptoms before alluded to under the head of premonitory, which would lead us to suspect the approach of inflammation of the pleura, or of the lung itself, the animal should at once be removed into a comfortable and airy hovel taking care at the same time to place it in such a way as not to expose it to any direct currents of air. It should then be bled, and repeated, if necessary, within a few hours; but we have generally found one bleeding suffice, except occasionally in stall-fed beasts or cattle in high condition.

Bleeding is the most valuable means we can employ in order to restrain or extinguish the incipient inflammatory action of the lungs or pleura at this period.

Some general rules may be laid down with respect to the manner and quantity in which blood should be extracted. The earlier it is performed after the above symptoms have appeared the better will be the chance of recovery. The patient should be bled from a large orifice and in a full stream, and continued until some decided effect is produced upon the system, which may be known by the pulse becoming stronger if it were oppressed, or lowered if previously strong and full; the quantity drawn will also depend upon these circumstances. After bleeding, it will be advisable to have recourse to medicines calculated to promote the discharge of the secretions, and at the same time diminish febrile excitement. This object will be best gained by the administration of a saline purgative combined with Potass. Nitrat. and Ant. Tart in something like the following form:

℞ Magnes. Sulphat. ℔j. to ℔jss.
Potass. Nitrat. ℥j. — ℥ij.
Ant. Pot. Tart. ʒj.

This may be given once a day (till the bowels are freely opened) in two quarts of warm gruel, made either of flour or oatmeal, or in the same quantity of linseed-tea.

Should the before-mentioned symptoms increase in severity, the beast become more spiritless, cough and heaving at the flank more frequent, grunting louder, appetite nearly or quite gone, with other symptoms indicating that the second stage of the disorder has set in. The antiphlogistic treatment should be at once discontinued, and extensive counter-irritation had recourse to, and also the exhibition of remedies that will best tend to arrest the effusion and promote its absorption. Mercury possesses this peculiar power in a certain degree, but it is a medicine that requires to be closely watched, as it is liable to produce superpurgation, but not of such an uncontrollable nature as we have sometimes observed in the horse, when the smallest dose would produce this effect; it should be combined with opium to guard its action upon the bowels, and given in thick gruel, as in the following form:

℞ Hydrarg. Chlorid. ℈j.
Ant. Pot. Tart. ʒj.
Pulv. Opii ʒss. three times a day.

A seton eight or ten inches in length, of coarse filleting, should be inserted on each side of the chest. The sides and front of the brisket, after being scrubbed with a coarse brush, and the hair removed with scissors, should be well rubbed with either of the following ointments:

No. 1. ℞ Hydrarg. Biniodid. ℥ss.
Pulv. Lyttæ ℥j.
Axungiæ ℥iv. Mix.

No. 2. ℞ Pulv. Lyttæ ℥vj.
Pulv. Euphorbii ℥ij.
Hydrarg. Bichlorid. ℥ss.
Axungiæ ℔iss.

Should great debility exist, the following tonic draught may be given twice a day.

℞ Ferri Sulph. ʒij.
Pulv. Gentianæ ʒij.
—— Sem. Cumini ℥ss.
Sp. Ætheris Sulph. ℥ss.

mixed in two quarts of gruel, to which half a pint of porter or ale may be added. Should diarrhœa exist, it may be checked by the use of opium and chalk given in starch gruel. This we have often found to suspend the further action of the bowels for a considerable time.

Particular attention should be paid to the diet. In the first stage this should consist principally of bran-mashes, gruel, linseed-tea, &c. But in this advanced and debilitating stage of the disorder, should the animal show any inclination to eat, it may be offered a few steeped oats, or malt-mashes, gruel, &c.: the skin should be kept warm with large rugs.

A great deal has been said in favour of the hydropathic system, and of its surprising powers in cutting short the course of this formidable disease. I have given it several fair trials, but so far from its proving of any service, I have had reason to think that its adoption accelerated the progress of the disorder.

As before stated, I consider the last stage of pleuro-pneumonia so utterly hopeless, that to persist in further treatment would not only be an useless and painful proceeding to the lingering and dying animal, but would be involving the proprietor in unnecessary expense, so that, in order to terminate its sufferings, I invariably recommend the beast to be slaughtered.

## XVIII.—*On the System of Planting and the Management of Plantations at Welbeck.* By J. E. Denison, M.P.

It has often been matter of regret, that so little is known of the early history of our old and most famous trees. This is perhaps little to be wondered at, from the great age to which some attain, requiring, to mark them throughout all their stages of progress and decay, the observation of many successive generations of men. But it happens not unfrequently that correct accounts of the early management of our modern woods and plantations are allowed also to pass away with the lives of those who planted them.

This increases the value of experiments carefully made, and of observations accurately noted. Such records have been for many years kept at Welbeck, where planting operations have been carried out on a very large scale. It is from these records, and with the assistance of the Duke of Portland's personal observations, that this paper has been prepared.

A hundred years ago there can have been no great quantity of wood at Welbeck, or through the adjoining parks of Worksop Manor, Clumber, or Thoresby. Now there are on the property of the Duke of Portland alone, in Notts 4334 acres of plantation, and 473 in Derbyshire.

Of the great oak trees at Welbeck, among the most remarkable in England, the Greendale Oak, the Great and Little Porters, the Seven Sisters, or of the magnificent trees, forming the wilderness before the house, varying from 12 to 19 feet in girth, and from 70 to 100 feet in height, nothing is known as to their age or early history.

They are probably of the wild and original growth of the forest of Sherwood.

The Greendale Oak was described as follows by Evelyn in his 'Sylva,' published in the year 1662.

"The oak which stands in Welbeck-lane, called Greendale Oak, hath at these several distances from the ground these circumferences :—

| | Feet. | Feet. | in. |
|---|---|---|---|
| At | 1 | 33 | 1 |
| | 2 | 28 | 5 |
| | 6 | 25 | 7 |

There are three arms broken off and gone, and eight very large ones yet remaining, which are very fresh and good timber."

In 1724, the centre was hollowed out into an arch, to allow a carriage to pass through; and it became the common object of a drive from Thoresby and the neighbourhood to drive to the Greendale Oak, to drive through it, and return home.

In 1775 an engraving of the tree, in its then state, was inserted in Hunter's edition of the 'Sylva;' one large arm alone then

remained. The drawing from which the accompanying woodcut has been taken was made in September of the present year by an artist on the spot. The one arm, though the bark is separated from the wood, still shows life, and puts into leaf, and produces acorns to this day.

The Greendale Oak.

The girth of the Great Porter at 4 feet from the ground is 27 feet 8 inches. It contains about 1100 feet of solid wood in the stem, about 1300 including the large arms.

But an oak tree of 100 years old of an average growth, will not contain more than 50 feet of timber. It seems difficult to estimate the number of years, or even of centuries, that would be required to bring to perfection such a tree as the Great Porter.

Lord Harley's plantation was sown in 1725, upon a spot which was an old liquorice garden. In 1811, there were found to be standing on one acre of ground 79 trees; they were 100 feet high. Some of these trees were measured in 1831, and again in 1843, and were found to have gained in value in the proportion of 15 to 8—although among them some trees, which had been measured two years before, had been found to have made no progress at all. This is accounted for by the woodman, from the fact that trees, which had made no progress, had had their heads mastered by their neighbours.*

It has been said, that an oak-tree of an average growth will at 100 years old be found to contain about 50 feet of timber.

A larch of 100 years old will contain about 80 feet.

There are many exceptions to this rule. An oak-tree on the lawn at Welbeck, of 100 years' growth, contains 107 feet, and a larch of 100 years old has been cut down, which measured 110 feet. But still, according to the experience at Welbeck, the average growth does not appear in the case of the oak to give above 50 feet, or in that of the larch above 80 feet.

An experiment of much interest as to the thinning of trees is in the course of proof among some young oaks planted near the Icehouse at Welbeck.

Four portions have been measured off in the Plantation, 20 square yards each, inclosed with a rail fence, and an inscription placed within:—

No. 1. *January*, 1827.—The oaks within these rails were sown in 1814. They have never been thinned hitherto. It is intended they should be left in a complete state of nature, without any interference of art, till the year 1864. The object of this experiment is to prove to those who may then be alive, by comparison with the neighbouring inclosures of the same size, the advantages to be derived from judicious thinning.

This inclosure contains now (1848) 128 trees.

No. 2. *January*, 1827.—The oaks within these rails were sown in 1814, and they have never been thinned hitherto. It is intended they should be left till the year 1864 in a state of nature, with this single exception—if a faulty tree take the lead, it may be removed. The object of this experiment is to prove to those who may be then alive, how much is gained by the judicious thinning of trees to those which remain.

This inclosure contains (1848) 144 trees.

No. 3. 1827.—The oaks within these rails were sown in 1814. They have never been thinned hitherto. It is intended that when they

* The trees measured in 1831 were valued at 5*l.* 4*s.* each; the wood being valued at 2*s.* per foot. Between 1831 and 1843 this plantation was manured, which may account for this great increase in their value.—Scott Portland.

seem to require it, they should be thinned in the manner usually practised here, in order to prove to those who may be alive in 1864, the benefit which may be derived to plantations from more or less thinning.

This inclosure contains (1848) 96 trees.

No. 4. 1827.—The oaks within these rails were sown in 1814. They have not been thinned hitherto. But it is intended that, as soon as they appear to require thinning, up to the year 1864, they shall be thinned twice as much as is usually the practice at Welbeck.

This inclosure contains (1848) 47 trees.

## *Method of preparing the Land for Sowing or Planting.*

The land is ploughed, cleaned, and fallowed, and dressed with bones at the rate of 40 bushels per acre. White turnips are then sown, which are eaten off with sheep.

Early in the year the land is again ploughed, and thrown into beds 4 feet wide; about 1 foot of the soil from an interval of 4 feet is thrown up on the other, which costs about 14*d.* per 28 yards for the 4-feet bed.

*Sowing.*—The acorns are sown as soon as the ground is ready, say January, about three quarters per acre, sown by hand in a grip made with a spade, nearly as thick as peas; three rows on a 4-feet bed. Traps are set for mice, and 1*s.* per score paid to boys who catch them, and at the same time keep off the birds.

*Planting.*—Two-year old plants of oak are used, three rows set in a 4-feet bed, the plants about 10 inches apart; they require hand-hoeing and weeding twice a-year for the first 3 or 4 years.

Hares and rabbits must be kept out by proper fences. They do more hurt to young chestnuts than to oaks.

The same year, or the following January, larch are planted in the intervals between the beds, one row down each alley, 2 yards apart.

The plantations are then left alone for about 12 years, the plants striving among each other for the mastery. If the woodman in looking round them should observe any of the oaks growing with very bushy heads, or very crooked, he would cut out such plants.

*Thinning.*—At the end of from 12 to 15 years, according to the goodness of the ground, thinning commences. The weakest plants, and those with dead heads, are cut out for hedge-bindings, averaging about 10 or 12 feet long. In the meantime a great many small trees will have been killed. A pretty good acre would yield 30 bunches of bindings (30 bindings in a bunch), value 6*d.* a bunch, costing 2*d.* cutting. After this the plantation would be looked over every year, and the weakest trees and any which are dying would be taken out. For about three years more they make only bindings; after that the trees are strong

enough for stakes, and then they are pealed; a pretty good acre will now pay from 1*l.* to 2*l.* a-year, and will improve in value every year.

The Larch will be cut as soon as they are fit for rails, beginning at about 15 years old, and taking those which are most in the way. The Larch would not all be taken out, till the plantation reached an age of 40 years.

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The only trees planted by the Duke of Portland are Oak, Spanish Chestnuts, and Larch.

*Spanish Chestnuts.*—The plantations of Spanish Chestnut are treated in all respects as those of Oak. They grow much quicker than Oak, but they are not thinned earlier, being left very close to prevent their shaking, which seems to be done by a twist of the wind. They make rails almost as soon as the oak make bindings. The bark sells for two-thirds the value of oak bark, they make very good posts, much more durable than young Oak with the sap, and more durable than young Larch. Chestnuts should be planted by themselves, because they outrun the Oak, and then they get caught and shaken by the wind. In the early years, during the process of thinning, they make a much better return than Oak; for stakes and posts and rails, they are more durable than Oak, and in more advanced stages they seem fully equal to oak for rafters and all building purposes.

*Larch.*—Until within the last six years, Larch appeared to be the most profitable of all woods; but about the year 1839, a terrible disease showed itself among Larch trees of all ages. Before this time every now and then a few Larch were found diseased in the plantations, chiefly in spots where they were much crowded and overtopped; but within the last eight years the disease has become general, attacking trees of all ages, in all situations, and on all soils, in many cases those which have plenty of room, as well as those which are crowded. Trees of above 90 years old, containing 110 feet of timber, have been found diseased, and from that age down to trees of 15 years, and even younger.

In the plantations near Sutton, in Ashfield, all the Larch have been cut down, and they were found so generally affected with the disease, that it was rare out of a thousand trees to find one quite sound. The cause of this disease has not been ascertained.* It seems a matter of serious doubt, whether it will be prudent to continue the plantation of Larch trees.

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* In a large district of plantations at Staple Fitzpain, Somerset, I planted one portion with plants raised from seed in Scotland, and another with plants raised in my nurseries from seed which I imported from the Alps. The former plants are much infected with disease; the latter are healthy and vigorous.—PORTMAN.

The following items form the cost of planting an acre of land on the system described :—

| | £. | s. | d. |
|---|---|---|---|
| Preparing ground for Turnips . . . . | 2 | 10 | 0 |
| 5 quarters of Bones at 7*s*. 6*d*. per quarter . . . | 4 | 7 | 6 |
| Ploughing ground over after the Turnips have been eaten off . . . . . . . | 0 | 8 | 0 |
| Throwing the ground into beds . . . . | 1 | 4 | 6 |
| 1 quarter of Acorns . . . . . . | 0 | 16 | 0 |
| Sowing the Acorns . . . . . . | 0 | 4 | 0 |
| 1000 Larches . . . . . . . | 1 | 0 | 0 |
| Poles, digging, and planting . . . . . | 0 | 7 | 6 |
| | 10 | 17 | 6 |

It would have been possible to have given the actual returns from an acre of plantation at different periods of its growth, and an estimate of the value of the growing wood. But plantations vary so much in their progress, according to the quality of the land on which they are planted, that a single instance, or a few individual instances, would have afforded no safe ground for a general conclusion.

The system of planting and thinning pursued at Welbeck is thought to combine a fair return of annual profit with the production of the largest growth of straight and profitable timber that can be obtained from a given surface of ground.

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Note.—My first plantations in Birkland were on old sheepfolds, in 1821. It is probable the dung of the sheep had been scraped up or carried off; for the trees have grown very ill. In 1825, 14 acres near it were fallowed by the plough, and sown with acorns. Between a part of this ground and the site of the old sheepfold, and close to the latter, there was a small bit of ground which could not be worked by the plough. As it was of no use there, and very full of twitch, it was digged three spades deep, merely with the view of burying the twitch, and planted with oaks. In 1847 I happened to see this ground, and I found that the oaks had far surpassed those planted before them; and judging that their great superiority arose from the quantity of soil, in which their roots were able to work without obstruction, I have adopted the same principle in all the plantations made in the following winter. The beds are made five feet wide. The top-soil is removed, and the bad soil thrown out. It is replaced not only with the top-soil originally thereon, but with an equal quantity taken from the five feet on each side of it. The bad soil is then thrown upon the top, and bones are sown with the plants planted in the bad soil. They have, therefore, a depth of three spadefuls of loose earth to grow in, the best soil being below; and the bad surface manured with bones. This plan has been eminently successful. The young plants have flourished amazingly, and hardly any have died. This applies equally to oaks and chestnuts. It is fair, however, to add, that the season has been more favourable for planting than any I ever saw.—Scott Portland.

## XIX.—*A few Notes on Scotch Fir and Larch, as to the Soil on which they grow best, and the preservation of the former, when used for Building purposes.* By Sir James Stuart Menteath, Bart.

The Scotch fir (*Pinus sylvestris*) thrives well but does not grow fast on the soil over the sandstone rocks.* Its wood, however, is tough and very durable. But when the same tree is planted on the greywacke, or argillaceous schistous slaty rocks, though it grows more rapidly, and arrives sooner at maturity, yet being softer and fuller of white wood than that grown upon the sandstone, the builder, to his cost, finds that it is soon attacked by the worm and decays.

The reverse of this happens with the larch (*Pinus larix*) when growing on the granitic formation, slaty or greywacke rocks. Its wood is sound and good ; and when cut down, is at heart generally perfect. But on the sandstones, chalky and limestone soils, it seems to be at maturity at an earlier age than that growing on the greywacke and granitic ; and in many instances, when cut down on these soils, the larch presents a tubed decayed heart. Under twenty years old such instances of internal decay appear : and it is remarkable, that externally to the eye the larch seems healthy and vigorous.

I may here state that the larch grows naturally only on the rimitive mountains, as the granite, gneiss, and the like rocks of that class of the Alps in Switzerland : and it is most curious to observe, that on the whole range of the Jura Mountains, separating that country from France, being a limestone formation rising to an elevation of several thousand feet, not a single self-sown larch can be discovered.

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* Some remarkable facts, respecting the durability that may be given to timber by artificial means, have been observed at Closeburn. The proprietor of that estate, the late Sir Charles G. Stuart Menteath, was in the constant practice of soaking all fir timber, after it is sawed into plank, in a pond of water strongly impregnated with lime. In consequence of this soaking, the saccharine matter in the wood on which the worm is believed to live, is either altogether changed or completely destroyed. Scotch fir wood employed in roofing of houses, and other in-door work, treated in this manner, has stood in such situations forty years, sound, and without the vestige of a worm. In a very few years fir timber so employed, without such preparation, would be eaten through and through by that insect. It might perhaps be advisable in all timber used for ship-building to soak it for some days in lime water.

Advancing, however, from this range into Switzerland, it may be observed that in those places, as at Chamouni, Mont Cenis, the Simplon, and the lofty Alps which partly enclose the beautiful Lake of Thun, in the Canton of Berne, where the primitive rock formation, consisting of granite, gneiss, mica slate, and similar rocks abounds, the larch is indigenous, growing luxuriantly, and attaining to a great size. Almost on the summit of the Simplon, upwards of 6000 feet of elevation above the sea, instances are met with of larches of 16 feet in circumference at some distance from the ground. Connected with the same formation are the largest larches found in Scotland, as at Dunkeld. One of the largest of these trees measures upwards of 18 feet in circumference; and they are of no great age, for it was only in 1738 that they were brought from the Alps, and planted at Dunkeld. From the progress they have made, and their present thriving appearance, it is probable they will attain a great age.

The durability of the larch throughout Switzerland is proverbial; and in all situations where exposure to weather must be encountered, such as roofing of houses, and the like, recourse is always had to larch, and, it is said, this external covering will last for nearly one hundred years. It is said that the piles on which Venice is built are of larch-wood. It would thus appear, that the greywacke slaty formation of rocks, approaching very near in qualities to the primitive granitic soil, is the best qualified to grow the larch. Before the introduction of mahogany wood into Europe, the Italian painters used larch panel, upon which to paint their oil pictures.

In the 'Civil Engineer and Architect's Journal,' No. xxviii., January, 1840, there is a notice at p. 27, describing a patent obtained in the United States of America, to preserve wood by boiling it in lime-water. The editor of this journal properly remarks, that wood might be much better prevented from decay by soaking it in a strong solution of lime in cold water.

Lime when fresh burned or calcined is soluble in about 800 times its weight in cold water; but in much less quantity in boiling. And thus, if wood be soaked in a cold water solution of lime, more of the calcareous substance will be imbibed by the pores of the wood; the sap and other vegetables of the wood will also be more fully exposed to the action of the lime-water, and more likely to undergo the chemical changes which seem necessary for the preservation of the wood, than when put into a boiling solution of lime-water.

The same editor states that he is unacquainted with any facts that confirm his opinion, that wood would derive more benefit, as to its future durability, by being steeped in a solution of lime in cold water. We are happy to supply some facts

which have lately fallen under our immediate observation, and which prove in the most satisfactory manner that wood, even of the most perishable description, may be preserved for many years previous to use, by soaking it for some days in a cold solution of lime-water.

The wood-work of a house used by the clerk of the lime-works at Closeburn, which has been erected upwards of forty years, and was constructed of common Scotch fir, of twenty-eight years growth, raised on the estate of Closeburn, discovers no symptoms of decay, either from being worm-eaten or otherwise injured by time. It was perfectly free of worms, and is nearly as sound as the day it was first put up. But in the smaller wood of this roof, we perceived many marks of the ravages of the worms upon it. These insects had penetrated it in every direction, and injured it to that degree that it must soon be replaced by fresh wood. This can be accounted for, why the large wood had escaped, and the smaller timber had fallen a prey to these tiny destructive creatures, that the larger timber had been soaked in the cold water solution of lime, but that the smaller had not undergone the same treatment.

The following detail is the method which the late Sir Charles G. S. Menteath employed to prepare his wood for building purposes.

It may, however, before proceeding to relate it, be remarked, that wood contains saccharine and albuminous substances. The latter, viz., the albumen, when the wood is placed in a damp and confined situation, very readily decomposes and passes into the disease called "dry rot," which proceeds from a plant of the fungus family, produced by the decayed rotten wood. The albumen, as well as the saccharine ingredients of the wood, furnish the food of the worm. Its parent, either a fly or a beetle, led by instinct to this already-prepared magazine of food for its offspring, lays its eggs in the wood. These eggs in due course of time give birth to the worms or maggots, which as soon as they issue from them commence their devastations upon the wood.

Lime-water is found to produce great changes on these vegetable elements of wood, the albumen and saccharine matters. Whether the alkaline properties of the lime destroy them, or enter into new combinations, is not well ascertained. These effects the chemist, perhaps, will be able to explain. Certain, however, it is, from the valuable instance of wood steeped in a cold solution of lime-water as seen in the roof at Closeburn lime-works, that wood, even of the most perishable kind, when well soaked in such a solution, is freed from the destruction of the worm—is also less liable to be attacked by *dry rot*—and is rendered durable and sound for years.

The wood which the late Sir Charles G. S. Menteath employed for roofing buildings is chiefly Scotch fir. He was in the practice of steeping this wood previous to using it, in a strong solution of lime-water for upwards of *forty* years. Scotch fir, that has not been soaked in lime-water, is known to last in the roof of buildings very few years; it soon is preyed upon by the worm.

The method pursued at Closeburn in preparing wood for the purposes of building is to saw it into such lengths as the occasion demands; next to plunge the planks or beams into a pond of lime-water. The pond is made 30 or 40 feet long, 5 or 6 feet deep, 16 or 18 feet wide; the bottom and sides are rendered water-tight. It is then filled with cold water. Before receiving the wood, a quantity of fresh-burned hot lime is thrown into the pond, which is well stirred with the water to dissolve as much as possible of it. Into this strongly impregnated solution of lime-water the wood, in the various shapes it has been sawn into, is then thrown in. As lime-water absorbs carbonic acid from the atmosphere, the lime previously held dissolved in the water, becomes insoluble and is slowly abstracted from the water, and deposited at the bottom in a solid state, as mild lime or carbonate of lime; hence the necessity of now and then throwing in fresh portions of recently-calcined lime, that the water may be resaturated with the strongest solution of this caustic alkaline earth.

With respect to the period that it is necessary to soak the wood in lime-water, it must depend very much upon the thickness and texture of the wood: roofing-timber of fir will require a fortnight or more; larger and closer-grained wood than the fir ought to be in the lime-water pond three or four weeks, or longer time.

After removing the wood from the pond it must be allowed to dry and season before it is used.

Among the benefits that this preparation of wood by the late Sir C. G. S. Menteath presents, we may safely enumerate the following, viz.:—

1. The lime which is absorbed by the pores of the wood appears to alter or destroy the albuminous and saccharine principles, and, destroying the food of the worm, saves the wood from its ravages.

2. The two last elements, viz., the albumen and sugar, having been so acted upon by the lime, there is less apprehension of its being infected by the "dry rot."

3. The wood, soaked in lime-water, becomes firmer in texture and more durable. It is the well-known property of waters holding lime in solution, called "*petrifying wells*," to penetrate and deposit upon all substances exposed to their influence small crystals of carbonate of lime.

When wood is plunged for some time in a strong lime-water solution a slight petrifaction of the wood is observable. The carpenter who has to work up the wood taken out of the lime-water pond, grievously complains that the edge of his plane is constantly blunted. This arises from the small crystals of carbonate of lime covering the surface of the wood; and also from their having insinuated and crystallized themselves into the pores of the wood; the plane in contact with these has its edge taken off. Was the wood prior to being put into the pond smoothed with the plane, this objection of the carpenter would be prevented.

From these few observations upon the late Sir Charles Menteath's treatment of building-timber, it must be apparent that no readier, no more economical method of preserving wood has yet been discovered.

In preparing wood for the purposes of ship-building, I think it would be well worthy of the attention of the ship-carpenter to ascertain by experiments, whether or not his wood, previously well steeped in strong lime-water, would not give it *at sea* the same durability which it is found to have done when so treated in buildings *on land.*

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## *Note by Lord Portman on the Preservation of Fir Timber.*

My experience has proved that Scotch and spruce fir, as well as larch, cut when full of sap, and at once plunged in running water, and kept therein three months at least, endures twice as long as when this plan is not adopted; and as the timber not so treated has perished, while the former is still perfectly sound, in buildings where the experiments have been tried, I believe the plan to be simple and efficient. The sawyer requires at least double pay for sawing the timber treated as I describe.

PORTMAN.

# XX.—*Report on the Exhibition and Trial of Implements at the York Meeting*, 1848. By H. S. Thompson.

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The Implements exhibited at York exceeded in number and variety those brought forward on any previous occasion. To sight-seers this alone must have been a strong recommendation; but to agriculturists, quality is of more importance than quantity, and it is satisfactory to be able to add, that the show-yard at this meeting contained a great number of well-tried machines of sterling merit, as well as a fair sprinkling of ingenious novelties, and was therefore in all respects well calculated to realize the objects for which such exhibitions are held.

As some difference of opinion exists respecting the precise objects sought to be attained by shows of implements, the writer of this Report thinks it desirable that he should briefly state his own views on the subject, as they must in some measure influence the reasoning and general tendency of the whole Report. The public will thus be enabled to judge for themselves whether the opinions which more or less pervade the whole are such as they can assent to.

The principal advantages to be derived from shows of implements may be classed under three heads, of which the first and most important is, that the awards of prizes should point out to every farmer who enters the show-yard, the best implements in their respective classes which the kingdom produces.

Farmers, as a body, have neither the means nor the leisure required for travelling about to visit the manufactories of the various implement-makers; nor, if this were practicable, could they safely decide on the comparative efficiency of their respective productions, by merely seeing them in the makers' yards. It is, therefore, a great advantage to the farmers of any district to have a large show of implements brought into their neighbourhood, especially when the best of each class are pointed out to them by competent judges after a fair trial. If this were more generally recognised as the main object of these exhibitions, it would entirely put an end to the disappointment which is sometimes felt at finding that a large proportion of the implements at every show have been exhibited on previous occasions. To novelty hunters, this is no doubt mortifying; but to those who visit the show-yard to ascertain which are the best implements of the day, it matters not whether they are of recent or of older date, and they will feel gratified rather than disappointed, that really sterling implements should give a fresh proof of their efficiency by winning an additional prize.

The York Exhibition was particularly satisfactory when viewed in this light, nearly all the eminent implement-makers in the kingdom being exhibitors, and the names of Cornes, Crosskill, Garrett, Hornsby, and Howard may be specially mentioned as

having won an additional mark of distinction at this meeting with implements which had been frequently rewarded on previous occasions.

The second head under which the advantages arising from shows of implements may be classed is, improvement in the construction and manufacture of the implements themselves. Many of the implement-makers are candid enough to acknowledge that they have received much benefit from attending the meetings of the leading agricultural societies, and a better illustration of this point can hardly be desired than the following very honest and instructive statement made in the presence of the writer, by an exhibitor who received prizes from the Royal Agricultural Society, both at York and Northampton. He said: "The first time I attended an agricultural show, I took a waggon-load of implements, which I thought as good as anybody's; but instead of winning prizes, I was found fault with by the judges for bringing such inferior articles to a show. I returned home excessively angry, thinking them very bad judges; but after a time I began to consider that they could have no object in annoying me, except for my own good, and that they might be right after all. I accordingly set to work to improve, and went to the persons whom I considered the best implement-makers of the day, Messrs. Ransome, and agreed with them for permission to use their improvements. Since then I have gone on improving, and been very successful."

An exhibitor who takes a defeat in this spirit can hardly fail of being ultimately successful, and it is gratifying to observe that the practice of purchasing the right of using the discoveries of others, is making considerable progress amongst the most enlightened implement-makers. Many instances of it occurred at York—of the two prize ploughs, Busby's and Howard's, one contained Messrs. Hensman's excellent mode of adjusting the coulter, and the other Messrs. Ransome's trussed beam; and numerous and valuable as have been the inventions of Messrs. Garrett and Hornsby, they have not allowed any feeling of self-sufficiency to prevent their availing themselves of the prize implements of Messrs. Coleman, Cornes, Read, Phillips, and Weller.

These, with many other instances which might have been quoted, are satisfactory proofs of the existence of a liberal spirit, which promises to have the best effect in bringing the most approved implements into general circulation. It will also, in all probability, tend to the advantage of the inventors themselves, as, however jealously an improvement may be confined to a particular workshop, it is exceedingly difficult to guard against piracy and evasion, and it is better on all accounts to make fair terms with other implement-makers than to be continually resorting to a court of law.

Another way in which exhibitions of implements lead to their improvement, is by keeping up that spirited competition between the principal implement-makers, which acts as a powerful stimulus to ingenuity and invention.

It is now very generally the custom for purchasers of implements to make their selection in the show-yard of the Royal Agricultural Society, or, if unable to be present, to wait for the reports of the judges before giving their orders.* It therefore becomes important for those who wish to take the lead in this branch of manufacture, to obtain a prominent position at these meetings, and no one who has watched, for the last few years, the keen competition between the leading implement-makers, can doubt its leading to good results. In fact, the great excellence observable in some departments (as, for instance, drills and tile-making machines) is doubtless due, in no small degree, to the anxiety felt to bring out each succeeding season some marked improvement, which shall enable the inventor to go ahead of his competitors, and prevent the next great race from ending, as it has sometimes threatened to do, in a dead heat.

The York Meeting was as satisfactory in the number of improvements brought forward as in other respects—one or two of which deserve especial mention on account of their very simple mode of removing a difficulty which very elaborate contrivances had hitherto failed to surmount. One of these is the invention of Messrs. Hensman of Woburn. It has always been difficult to make a drill do its work well on hilly ground. Several contrivances have been introduced for this purpose, such as altering by a screw the inclination of the manure or seed-boxes, or using a slide which partly closes the opening through which the corn passes from the hopper; but the effect of these and other devices was entirely dependent on the judgment with which they were applied by the drill-man, and it was clearly impossible for him to estimate by the eye, with any accuracy, the steepness of a slope over which he was passing, or to adjust his drill to an inclination which, on undulating land, altered at almost every step; so that all these contrivances were but mitigations of an acknowledged defect. Messrs. Hensman have the merit of introducing the very simple but perfectly effective method of letting the drill *adjust itself*. This is effected by suspending the hopper in such a way that its own weight always keeps it perpendicular, and thus, on the steepest hill-side, the delivery of the seed goes on at precisely the same rate as on a dead level, without its being necessary to make any alteration whatever in the adjustment of the drill.

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* One of the exhibitors at York stated that he received during the week sixty orders for one of his prize implements.

A similar principle has been introduced into the liquid manure-carts exhibited by Mr. Stratton. All those hitherto exhibited have been found fault with, from the circumstance of their delivering their contents with great irregularity when the liquid got low; and this was greatly aggravated if the surface of the land was at all uneven, so that the alternative was presented of taking home a fourth or fifth of the contents whenever the cart returned to the tank to fill, or to water a portion of the ground in a very irregular way, the liquid sometimes rushing out in a full stream, and sometimes stopping altogether, according to the motion of the horse or the irregularity of the land. (The writer has to complain this season of marked unevenness in a green crop for soiling from this cause.) This inconvenience is altogether avoided in Mr. Stratton's implement, which consists of a wooden or iron barrel revolving on its axle. One side of the barrel consists of a perforated board, which is kept uppermost when not at work, and to set it to work it is only necessary to turn the barrel round. Thus valves and delivery-pipes are altogether unnecessary, and, however hilly the land, or however nearly empty the barrel may be, it will always adjust itself by its own weight, and deliver its contents at a uniform rate. As a natural consequence of this greater simplicity of construction, the price is considerably lower than that of any liquid manure-cart (if this can be called a cart) hitherto exhibited.

The third head under which the advantages of implement-shows may be arranged consists of the assistance they render the Society in a financial point of view. A "Steward of Implements" may perhaps be excused for considering his own department the *most attractive* part of the show; but, after making all due deduction for the partiality of the writer, it is clear that the implement-yard *adds largely* to the attraction of these meetings. This is a point of no small importance, as it should be borne in mind that the expense of the show-yard and other arrangements is so great, that, unless a considerable sum were raised by the sale of admission-tickets, the Society would be unable to continue the country meetings on their present liberal and comprehensive scale. This third head may therefore be considered as supplying the means of realizing the advantages pointed out in the first two divisions of the subject, viz.:—

1. General diffusion of the best existing implements.
2. Continued progress in their improvement.

These remarks cannot be more appropriately concluded than by the mention of a very gratifying incident of the York Meeting, viz., that a large proportion of the agricultural labourers who visited the show-yard, instead of paying 1*s*. each for tickets-of-admission at 2 p.m. (as had been almost universally the practice of

this class on previous occasions), bought half-crown tickets,* which admitted them at 6 a.m., and many of them were heard to express their determination to "make a day of it," and have a "real good look at the implements." This fact, whether viewed as a proof of the interest taken by this class in the proceedings of the Society, or as indisputable evidence of their comfortable, and even thriving, condition, is to a Yorkshireman one of the most satisfactory features of this very brilliant and successful Meeting.

PRIZES OFFERED BY THE SOCIETY.

| | |
|---|---|
| For the Plough best adapted to heavy land . . | Ten Sovereigns. |
| For the Plough best adapted to light land . . | Ten Sovereigns. |
| For the best Skim or Paring Plough . . . . | Five Sovereigns. |
| For the best Drill for general purposes, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered . . . . . . . . . . | Fifteen Sovereigns. |

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

| | |
|---|---|
| For the best Turnip Drill on the flat, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered | Ten Sovereigns. |

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

| | |
|---|---|
| For the best Turnip Drill on the ridge, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered . . . . . . . . . . . | Ten Sovereigns. |

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

| | |
|---|---|
| For the best Implement for distributing Pulverized Manures broadcast . . . . . . | Ten Sovereigns. |
| For the best Horse Seed-Dibbler . . . . . | Ten Sovereigns. |

* The admission tickets sold at York on the Thursday may be stated in round numbers as follows:—

| | |
|---|---|
| Half-crown tickets . . | 14,000 |
| Shilling ditto . . . . | 10,000 |

Whereas on all previous occasions a considerable majority of shilling tickets were sold. It should, however, be observed, that the time at which the price of admission was reduced to 1*s.* was one hour later at York than at former meetings.

| | |
|---|---|
| For the best Scarifier or Grubber . . . . . | Ten Sovereigns. |
| For the best Harrow . . . . . . . . . | Five Sovereigns. |
| For the best Machine for making Draining Tiles or Pipes for Agricultural Purposes. Specimens of the Tiles or Pipes to be shown in the Yard: the price at which they have been sold to be taken into consideration, and proof of the working of the Machine to be given to the satisfaction of the Judges . . . . . . | Twenty Sovereigns. |
| For the best Waggon . . . . . . . . . | Ten Sovereigns. |
| For the best One-Horse Cart . . . . . . | Five Sovereigns. |
| For the best portable or fixed Steam Engine, applicable to Thrashing, or other Agricultural purposes . . . . . . . . . . | Fifty Sovereigns. |
| For the best and most economical Steaming Apparatus for general purposes . . . . . . | Ten Sovereigns. |
| For the best Thrashing-Machine applicable to Horse or Steam-power . . . . . . . | Twenty Sovereigns. |
| For the best Corn-dressing Machine . . . . | Ten Sovereigns. |
| For the best Gorse-Bruiser . . . . . . . | Five Sovereigns. |
| For the best and cheapest Grate or Stove for Cottages, combining safety and economy of fuel with effectual warmth and facility for cooking. | Five Sovereigns. |
| For the best Grinding Mill for breaking Agricultural Produce into fine Meal . . . . . . | Fifteen Sovereigns. |
| For the best Hand Drilling Machine for Depositing Carrot, Mangold-wurzel, or Turnip Seed | Five Sovereigns. |
| Miscellaneous Awards . . . | Not exceeding Twenty Silver Medals. |

For the Invention of any New Implement, such sum as the Council may think proper to award.

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JUDGES.

| | |
|---|---|
| RICHARD CLYBURN | Uley, Gloucestershire. |
| W. N. PARSSON | Gravel Lane, London. |
| T. P. OUTHWAITE | Bainesse, Yorkshire. |
| WILLIAM HESSELTINE | Worlaby, Lincolnshire. |
| PETER LOVE | Naseby, Northamptonshire. |
| CHARLES PAGET | Ruddington Grange, Nottinghamshire. |
| OWEN WALLIS | Overstone Grange, Northamptonshire. |
| JOHN ALMACK, Jun. | Leckonfield Park, Yorkshire. |
| THOMAS BAYLDON | Hollingshurst, Yorkshire. |
| WILLIAM LISTER | Dunsa Banks, Yorkshire. |

CONSULTING ENGINEER—C. E. AMOS (of the Firm of EASTON and AMOS), The Grove, Southwark, Surrey.

AWARDS.

| Description of Implement and Name of Exhibitor. | Prize. | Reference to Catalogue. Stand. | Article. | Price. £. s. d. |
|---|---|---|---|---|
| PLOUGHS. | | | | |
| To William Busby, of Newton-le-Willows, near Bedale, for his Iron Plough with Two Wheels, for heavy land; invented, improved, (Ransome's Truss Beam) and manufactured by the exhibitor . . . . . | £10 | 81 | 1 | 5 0 0 |
| To John Howard and Son, of Bedford, for his patent Iron Plough with Two Wheels, for light land, marked JA No. 2; invented and manufactured by the exhibitors . . | £10 | 32 | 2 | 5 0 0 |
| To George Kilby, of Queniborough, near Leicester, for his Turf and Stubble Paring Plough; invented, improved, and manufactured by Thomas Glover, of Thrussington, near Leicester . . . . . | £5 | 114 | 6 | 5 10 0 |
| DRILLS. | | | | |
| To Richard Hornsby, of Spittlegate, Grantham, for his Drill for general purposes, and Distributing Compost; invented, improved, and manufactured by the exhibitor . . | £15 | 21 | 1 | 53 0 0 |
| To Richard Garrett, of Leiston Works, near Saxmundham, for his Four-row Turnip Drill on the flat, and for Distributing Compost; invented and manufactured by the exhibitor | £10 | 87 | 6 | 27 12 0 |
| To Richard Hornsby, of Spittlegate, Grantham, for his Two-row Turnip Drill on the ridge, and for Distributing Compost; invented, improved, and manufactured by the exhibitor . . . . . . | £10 | 24 | 4 | 24 0 0 |
| To Richard Hornsby, of Spittlegate, Grantham, for his machine for Distributing Pulverized Manures broadcast; invented, improved, and manufactured by the exhibitor | £10 | 21 | 6 | 14 0 0 |
| HORSE SEED-DIBBLERS. | | | | |
| To James Wilmot Newberry, of Hook Norton, near Chipping Norton, for his Seven-rowed Dibbling Machine; invented and improved by Saunders and Newberry, and manufactured by the exhibitor . . . | £10 | 3 | 1 | 60 0 0 |
| SCARIFIERS OR GRUBBERS. | | | | |
| To John Wood Sharman, of Wellingborough; William Proctor Stanley, of Peterborough; and Thomas Johnson, of Leicester, for their Patent Scarifier with seven wrought-iron tines; invented by Arthur Biddell, of Playford, and improved and manufactured by Ransome and May, Ipswich . . . | £10 | 124 | 1 | 18 18 0 delivered in London. |

| Description of Implement and Name of Exhibitor. | Prize. | Reference to Catalogue. | | |
|---|---|---|---|---|
| | | Stand. | Article. | Price. |
| | | | | £. s. d. |
| HARROWS. | | | | |
| To John Howard and Son, Bedford, for their set of Patent-jointed Iron Harrows, consisting of three harrows and whippletree; invented by W. Armstrong and J. Howard, of Bedford, and manufactured by the exhibitors. | £5 | 32 | 16 | 5 15 0 |
| DRAIN-TILE OR PIPE-MACHINES. | | | | |
| To John Whitehead, of Preston. for his Machine for making any description of Tiles or Pipes; invented and manufactured by the exhibitor | £20 | 141 | 1 | 23 0 0 |
| WAGGONS. | | | | |
| To Richard Stratton, of Bristol, for his tipping Waggon, with patent wrought-iron wheels; invented by the exhibitor; improved by P. B. Purnell, Esq., Stancombe Park, Dursley, and manufactured by the exhibitor . . . | £10 | 126 | 35 | 34 0 0 |
| CARTS. | | | | |
| To John Eaton, of Woodford, near Thrapstone, for his One-horse Cart ("Eaton's Patent, No. 1"), with harvest shelvings; invented, improved, and manufactured by the exhibitor | £5 | 30 | 1 | 12 10 0 |
| STEAM ENGINES. | | | | |
| To Richard Hornsby, of Spittlegate, Grantham, for his six-horse power portable Steam-Engine; invented, improved, and manufactured by the exhibitor . . . . . | £50 | 24 | 7 | 255 0 0 |
| STEAMING APPARATUS. | | | | |
| To Sharman of Wellingborough, Stanley of Peterborough, and Johnson of Leicester, for their portable Steam-Generator with Compound Tub and Vegetable Pan; invented by W. P. Stanley, of Peterborough, and William Medworth, London; and manufactured by W. P. Stanley, of Peterborough | £10 | 124 | 16 | 15 10 0 to 23 0 0 |
| THRASHING MACHINES. | | | | |
| To Richard Garrett, of Leiston Works, Saxmundham, for his four-horse power Bolting Thrashing Machine, with registered Straw-shaker; invented and manufactured by the exhibitor. *Price, as a fixture, 54l.; if portable, 61l. 10s.* . . . . . | £20 | 87 | 14 | 54 0 0 to 61 10 0 |
| CORN-DRESSING MACHINES. | | | | |
| To Richard Hornsby, of Spittlegate, Grantham, for his registered Corn-dressing Machine; invented, improved, and manufactured by the exhibitor . . . . . . | £10 | 24 | 11 | 13 10 0 |

| Description of Implement and Name of Exhibitor. | Prize. | Reference to Catalogue. | | |
|---|---|---|---|---|
| | | Stand. | Article. | Price. £. s. d. |
| **Gorse-bruisers.** | | | | |
| To Barrett, Exall, and Andrewes, of Katesgrove Iron-works, Reading, for their Gorse cutting and bruising Machine; invented and manufactured by the exhibitors . . . | £5 | 59 | 13 | 25 0 0 |
| **Cottage Grates or Stoves.** | | | | |
| To William Newzam Nicholson, of Newark-on-Trent, for his Cottage Range with registered improvements; invented, improved, and manufactured by the exhibitor . . . | £5 | 11 | 21 | 2 2 0 |
| **Miscellaneous.** | | | | |
| To Thomas Abbey, of Dunnington, near York, for his four-horse portable Thrashing and Winnowing Machine; improved and manufactured by the exhibitor . . . | Silver Medal. | 102 | 2 | 60 0 0 |
| To Robert Blundell, of No. 13, Thiberton Street, Islington, for his Agricultural Drainage Level; invented by the exhibitor and manufactured by Horne and Co., 123, Newgate Street, London . . . . | Silver Medal. | 7 | 1 | 4 0 0 |
| To Bobert Bruckshaw, of Longslow, near Market Drayton, for his Compound Lever Cheese-Press; invented and manufactured by the exhibitor . . . . . . | Silver Medal. | 80 | 8 | 3 10 0 |
| To Charles Burrell, of Thetford, for his portable Thrashing and Dressing Machine; invented by Walter Palmer, of Southacre, improved and manufactured by the exhibitor . . | Silver Medal. | 48 | 2 | 85 0 0 |
| To William Busby, of Newton-le-Willows, near Bedale, for his Grass-land Cultivator; invented, improved, and manufactured by the exhibitor . . . . . . | Silver Medal. | 81 | 21 | 8 8 0 |
| To William Busby, of Newton-le-Willows, for his Horse-Hoe on the Ridge; invented, improved, and manufactured by the exhibitor . | Silver Medal. | 81 | 17 | 2 0 0 |
| To Thomas Chandler, of Stockton, near Heytesbury, for his Liquid Manure Drill; invented by the exhibitor, and manufactured by R. and J. Reeves, of Bratton, Wilts . . . | Silver Medal. | 61 | 2 | 22 0 0 |
| To John Cornes, of Barbridge, near Nantwich, for his registered Chaff-cutting Machine with three Knives; invented and manufactured by the exhibitor . . . . . . | Silver Medal. | 85 | 5 | 14 0 0 |
| To William Croskill, of Beverley, for his improved Norwegian Harrow, with three sets of rowels on round axles; improved and manufactured by the exhibitor . . . | Silver Medal. | 64 | 82 | 12 0 0 |

| Description of Implement and Name of Exhibitor. | Prize. | Reference to Catalogue. Stand. | Article. | Price. |
|---|---|---|---|---|
| | | | | £. s. d. |
| To William Croskill, of Beverley, for his Archimedean Root-washer; improved and manufactured by the exhibitor . . . | Silver Medal. | 64 | 61 | 5 0 0 |
| To Deane, Dray, and Deane, of No. 3, Arthur Street East, near London Bridge, for their Cesspool and Tank Cleanser; invented and manufactured by the exhibitors . . | Silver Medal. | 134 | 4 | 31 10 0 |
| To Richard Garrett, of Leiston Works, for his patent Horse-Hoe on the flat, No. 9; invented and manufactured by R. Garrett and Son . | Silver Medal. | 87 | 11 | 18 0 0 |
| To William Hensman and Son, of Woburn, for their Horse Drag Rake; improved and manufactured by the exhibitors. . . | Silver Medal. | 117 | 14 | 7 7 0 |
| To William Hensman and Son, of Woburn, for their Self-acting Hopper, as applied to their Drill; invented and manufactured by the exhibitors . . . . . . | Silver Medal. | 117 | 9 | .. |
| To George Howe, of 119, Great Guildford-street, Southwark, for his improvements in the transparent Water-Gauge as attached to his Steam-engine; invented and manufactured by the exhibitor . . . . . | Silver Medal. | 22 | 1 | .. |
| To William Newzam Nicholson, of Newark-on-Trent, for his strong machine for Breaking Oil-cake for Beasts; invented and manufactured by the exhibitor . . . . | Silver Medal. | 11 | 4 | 6 0 0 |
| To Richard Robinson, of Belfast, for his Apparatus and Machinery for Steeping, Breaking, and Scutching Flax; invented by R. B. Schenck, of New York, and manufactured by the exhibitor . . . . . . | Silver Medal. | 25 | 2,<br>3, &<br>4 | ..<br>35 0 0<br>12 10 0 |
| To Richard Robinson, of Belfast, for his Steaming Apparatus, invented by Isaac Jennings, of New York; improved and manufactured by the exhibitor . . . . . | Silver Medal. | 25 | 6 | 9 10 0 |
| To Sharman of Wellingborough, Stanley of Peterborough, and Johnson of Leicester, for their Linseed and Corn Crushing-machine; supposed to be invented by Messrs. Bond, of Ipswich, and improved and manufactured by W. P. Stanley, of Peterborough . . | Silver Medal. | 124 | 15 | 11 11 0 |
| To Smith and Co., of Stamford, for their patent Double-action Haymaker; invented, improved, and manufactured by the exhibitors | Silver Medal. | 94 | 1 | 15 15 0 |
| To John Summers, of Wold Newton, near Bridlington, for his Implement for removing Shocks of Corn, &c.; invented and manufactured by the exhibitor . . . . | Silver Medal. | 97 | 2 | 0 9 0 |

*Ploughs.*—The following is the Judges' Report of the trial of the ploughs:—

*Ploughs for Heavy Land.*—"The land was of excellent character for testing the merits of these ploughs; there were twenty-two in number, some with two wheels, some with one; while others worked as swings. We directed these ploughs not to work less than 8 inches deep, and what width of furrow the makers chose to take. Those with one wheel, and also the swings, gave us very little trouble in deciding where to place them. The land was strong, and whilst most of those with two wheels were doing their work pretty well, the former were working very indifferently, not one of them turning the furrows in the style we approved. We considered Mr. Busby, of Newton-le-Willows, to deserve the first prize. His plough worked 9 inches deep, with a 13-inch furrow-slice, four horses drawing it in very good style, whilst others, which were not ploughing either so deep or so wide a furrow by 1 or 2 inches, could scarcely be drawn at all by the same number of horses. This plough cut the land side clean, made a level sole, kept the furrow more together and turned it in better style than any other in the field. The second best was Messrs. Barrett and Ashton's of Hull, marked T. S. This plough made very good work, ploughing 9 inches deep with a 13-inch furrow-slice; cut the land-side clean, and made a very good sole; the horses drawing it with as much ease as one might imagine they well could do with that width and depth of furrow. The furrow was more broken than Mr. Busby's; this we attributed to the shape of the furrow-turner, which was too hollow in the centre; from this cause it did not turn the furrow soon enough, but left too much work to be done at the last, and broke the furrow more than if it had been turned more gradually. We considered Messrs. Howard of Bedford's plough, marked J. A., the third best. This plough obtained the prize on the light land with the same furrow-turner. In our opinion Messrs. Howard were wrong in attempting to obtain the two prizes with the same furrow-turner: it is impossible, if a plough work well at a depth of 5 or 6 inches, that the same plough can work well when 9 inches deep. If the Society offered but one prize for the best plough for general purposes, and did not permit the mouldboard to be altered for different depths, the case would be very different. This plough worked very well up to 7 inches deep, but was not master of the furrow when deeper. We have no doubt that Mr. Howard saw his error and will be better prepared another year. Mr. John Bruce, of Tiddington, deserved credit for his plough, which was the fourth best.

"Mr. John Bird, of Bridge Casterton, competed with the same plough, which was highly commended for its work on the light land. It worked pretty well at 7 inches deep, but, like Mr.

Howard's, could not go the depth we wished it to do. So long as the Society offers two prizes, one for heavy and another for light land ploughs, we hope no one will attempt to obtain the two prizes with the same furrow-turner. We should be glad to see the same plough, with furrow-turners calculated for each description of work, take both prizes, and that is the object at which, in our opinion, the manufacturers should try to arrive."

*Ploughs for Light Land.*—"These were twenty-three in number. The trial took place on a clover-lea, of excellent quality for testing the good and bad properties of light ploughs. The plan adopted was for each to plough a land by himself not less than 5 inches deep, and any width of furrow the exhibitors pleased. In consequence of the improvements which have taken place in these implements, and particularly in the furrow-turners, it has become a difficult task for judges to come to a decision. With one or two exceptions the ploughs worked exceedingly well. After a very close inspection we decided that Messrs. Howard of Bedford's plough (J. A.) was the best. We considered the furrow-turner pretty near perfection and calculated to plough any description of land that plough can do; we had no hesitation, therefore, even amongst this numerous and excellent class, in deciding in favour of this plough. The second to this was exhibited by Messrs. Sharman and Co., but invented by Messrs. Faux, of Yaxley. This plough, marked S. P., made very excellent work, but we were of opinion that, from the shape of the furrow-turner having too much turn at the tail part, it would not run so level on the sole as it ought to do. We considered great credit due to Mr. John Bird for his plough marked A. L., which was third best. This plough made very good work, not much inferior to the former."

*Skim or Paring Plough.*—"In this class we had a great variety of implements, three of which were broadshare ploughs, intended to pare old grass-land for burning, but would work as stubble-paring ploughs when required; the rest were skims, intended only for paring stubbles. Although the broad-share ploughs did not get through quite so much work in paring stubbles as the skims, we considered that it was more effectually done; for while the skims cut through the land and left it much in the same position as when uncut, the ploughs turned it completely over, thus giving the harrows a much better chance of separating the soil from the weeds. The prize was awarded to Mr. G. Kilby, of Queniborough, near Leicester, for his turf and stubble paring plough, which was well adapted for both descriptions of work. We have no hesitation in stating our opinion that it would pare old grass land as well as any handspade-man, at a cost of not more than 4*s.* per acre."

The foregoing Report of the judges of ploughing requires

neither note or comment, and it only remains to mention that, during the interval which elapsed between the private, or judges' trial, and that to which the public were admitted, the ploughs were as usual left in the trial-field, which afforded an opportunity to some mischievous or malicious person to break off the head of one of the adjusting screws of Mr. Busby's prize plough. In justice to the owner of the plough, as well as to the judges who assigned it the first place, it should be generally known that the very indifferent work made by this plough at the public trial was entirely due to this cause.

*Drills for General Purposes* (Judges' Report).—"This prize was awarded to Mr. Hornsby for his ten-coulter corn, seed, and manure drill. It did its work in a very efficient manner, delivering the manure with great regularity, and though tried in rough ground, the clods did not accumulate between the coulters and carry the soil before the drill, which was the case with many that were exhibited. It was fitted with two stirrers in the manure-box, either of which could be stopped or put in motion as the drill was going on. The judges commended Mr. Garrett's drill shown for the same prize, which, though equal to Mr. Hornsby's in many respects, did not work so well on the rough ground, as the manure-pipes were occasionally stopped by the clods, and it carried them before the coulters, if not kept clear by the man attending it."

*Turnip-Drills on the Flat* (Judges' Report).—"The only drills that came into close competition for this prize were those of Mr. Garrett and Mr. Hornsby, and their working merits in the field were so nearly equal that the judges could not decide which was entitled to it. In this dilemma they obtained the opinion of the consulting engineer as to their mechanism and workmanship, and he, thinking some parts of Mr. Garrett's more highly finished than that of Mr. Hornsby's, the prize was awarded to Mr. Garrett. Mr. Hensman, of Woburn, exhibited a well made steerage-drill for this prize, which possessed some good contrivances for raising up or pressing down the coulters when required, but it was inferior to the above in distributing the manure."

*Turnip-Drills on the Ridge* (Judges' Report).—"This prize was awarded to Mr. Hornsby's drill, as there was a most striking superiority in the appearance of the ridges drilled by it over those of any other; this was owing to an improvement introduced by Mr. Hornsby, in putting the manure-coulters before the concave rollers, so that the ridges were brought again into proper form, although very much flattened by the large manure-coulters having passed up them."

*Hand Drilling-machines.*—"Only one implement was exhibited in this class, and as that was thought to possess but little merit, the prize was withheld."

The judges commended a steerage corn drill exhibited by Mr.

Hensman of Woburn, and awarded a silver medal to his self-acting hopper, on a new principle, by which the seed was sown at the same rate when going up or down hill as on the level.

They also awarded a medal to a liquid manure drill exhibited by Mr. Chandler of Stockton, Wilts, which was both novel and ingenious, and performed its work extremely well.

The preceding classes of drills comprise some of the most important implements used in agriculture; and as they have now been brought to considerable perfection, the leading drill-makers would confer a great boon on the farmers of this country, if they were to apply the same persevering ingenuity to simplifying and cheapening them, which they have hitherto employed in making them effective. The outlay required for the purchase of a drill of all work (50*l.* to 60*l.*) is an important matter even to large farmers who can afford to buy a first-rate implement, and who have an intelligent foreman capable of properly adjusting it for its various uses; but to the great majority of farmers an implement of this value would be utterly disproportioned both to their means and to the extent of their holdings; it is therefore highly desirable that the same improved principles which make the large drills so effective should be applied to a cheap and simple machine for one purpose only, requiring consequently little alteration or adjustment, and the demand for them would, in the opinion of the writer, be so extensive, that their manufacture might be remunerative, even though the profit on each were small. It is to the leading manufacturers that these remarks are principally addressed, as they have the means of supplying a large increase of demand, and those alone whose business is on a large scale, can afford to work at a low rate of profit. The attention of these parties is particularly directed to the fact that, in addition to the prize for drills for general purposes, the Society has announced a prize for the best corn-drill at the Norwich Meeting, and as there are many drills which deliver the seed with great regularity, it is probable that, in the absence of any marked superiority in this respect, the judges will attach great importance to simplicity of construction and lowness of price.

*Broadcast Manure-Distributor* (Judges' Report).—"This prize was awarded to Mr. Hornsby, whose machine, in addition to the usual apparatus for delivering the manure from the box, was supplied with a square iron bar, which revolved with great rapidity as the manure fell upon it, and assisted very much in spreading it evenly over the ground. The next best was Mr. Garrett's; but from his machine the manure fell upon the ground in perceptible rows. Mr. Crosskill exhibited for this prize a machine which was well adapted to sow lime, soot, ashes, or any perfectly dry manure, but the grooves in the roller (by which the manure was thrown from the box) soon became filled up when any damp

substance was employed, so that instead of a fluted roller, as it was intended to be, it quickly became a plain one, and ceased accordingly to act on the manure."

*Horse Seed-Dibblers* (Judges' Report).—"In this class there were only two machines to which we considered that we could apply the name of dibblers; these were exhibited by Mr. Newberry, of Hook Norton, near Chipping Norton. We awarded the prize to his seven-rowed dibbler, being of opinion that some improvement had been made in the regularity with which it deposited the seed. Out of thirty holes, the greatest number of grains deposited in any one was eleven, and the smallest number five, whilst in most of them seven or eight were dropped, which was the number that Mr. Newberry professed to be sowing, and which he stated to be at the rate of about 5 pecks to the acre. Another improvement had been introduced in this machine which made it deposit the seed more correctly in the holes, so that, on the whole, we thought it well worthy of the prize."

*Scarifiers or Grubbers* (Judges' Report).—"Nineteen of these implements were selected for trial. We could not see any improvement in this class since last year. They were set to work on a tare stubble where the soil was a strong clay; the tares having been recently removed, we considered the land in a very fair state for testing their merits. Being such strong clay, none but those on a good principle could make anything of it at all. The prize was awarded to J. W. Sharman and Co. for their 'Biddell's Scarifier.' This implement is decidedly superior to any other that the judges have seen in its capability of adjustment to uneven surfaces. It is well known that land cannot be properly scarified unless it be worked both lengthways and across the lands. When working lengthways, and either wheel runs in the furrow, Biddell's Scarifier admits of being raised on that side independently of the centre or opposite side, so that the tines work at the same depth at the edge of the furrow that they do away from it, and the adjustment is so simple, that if required it may be frequently altered without any difficulty or material delay. The 'Uley Cultivator' was exhibited by Mr. Crosskill, and worked very well where the land was level, but was not equal to Biddell's for ridge and furrow. The implements exhibited by James Kirkwood, of Tranent, East Lothian, and David Harkes, of Mere, near Knutsford, worked very well, but on account of the stiffness of the clay, they being of a lighter construction, could not equal the work of the other two implements."

The foregoing Report furnishes additional proof of the propriety of separating "scarifiers" and "grubbers" into distinct classes, and offering a prize for each. So long as one prize only was offered, the judges had no option, but were obliged to set implements of different calibre, and adapted for

different purposes, to the same kind of work. Thus they report that the cultivators of Messrs. Kirkwood and Harkes, though working very well, had no chance *on such very strong land*, in competition with more powerful implements, such as Biddell's scarifier, or the Uley cultivator; on the other hand, had these implements been tried on free-working land, or on any land where the object was only to "scarify" or pare the surface, some of the lighter implements, which are cheaper and require less horse-power, would probably have done the work equally well. The decision of the judges was no doubt quite correct under the circumstances, as it is both more difficult and far more important to produce an implement that is capable of doing its work well on heavy, than on light land; but it is nevertheless evident that two classes of implements were here competing for one prize.

The Society's prize has hitherto been offered for the best "scarifier or grubber." "Grubber" is a Scotch word, and it will therefore be more intelligible to the members of the Royal Agricultural Society, if the English word "cultivator," which is perfectly synonymous with "grubber," be exclusively applied to that description of implement. The use of the "cultivator," instead of the plough, for breaking up stubbles, is one of the modern improvements in husbandry, which is fast spreading, and will create a rapidly increasing demand for implements of this class. It is therefore important that both those who make and those who use them, should have their attention strongly drawn to the purposes to which they are to be applied, and that the one may be cautioned against manufacturing, and the other against buying the hybrid machines, half-cultivator, half-scarifier, which have made their appearance in such numbers within the last two or three years. These machines are evidently intended to act both as cultivators and scarifiers; and to prove that they, like other "Jacks of all trades," are also "masters of none," it is necessary briefly to point out the particular kinds of work for which cultivators and scarifiers ought to be respectively adapted.

A cultivator is intended to break up land instead of ploughing, or thoroughly to stir and expose to the atmosphere that which has been already ploughed. For these purposes it is necessary that the implement should work at some depth, say from three to five inches; it therefore requires a strong team of horses, and to bear this strain it must be made substantial, and consequently expensive. A scarifier, on the other hand, is intended for clearing the *surface* of the land, and is especially useful in the preparation of bean, pea, or tare stubbles, which are to be sown with wheat. For these purposes it is not necessary to go more than two inches deep, as the thinner the slice it can cut, without what is termed "slipping its work," the easier the draught, and the less the stubble and weeds will be encumbered with loose

soil. A scarifier therefore ought to work with two or at most three horses, and may be made light and cheap. Thus it is plain that every farm of any size ought to be provided with both cultivator and scarifier, as it now is with heavy and light harrows.

The temptation is no doubt strong to purchase one of the hybrid implements previously mentioned, in the expectation that by setting it a little deeper than is required for scarifying, it may supersede the apparently cumbrous four or six-horse implements. This is, however, short-sighted policy, and can only end in disappointment. Stubbles, from having remained unstirred during the summer months, are always firm and solid; and though the degree of hardness of different soils varies much, there is not by any means a corresponding difference in the amount of power required to break them up, as the lighter the land, the deeper the roots of the couch-grass will go, and the great advantage of using the cultivator rather than the plough is, to work below the roots of the couch-grass, and bring up the bunches unbroken If land be broken up by the cultivator when moist, it may be done with at least one horse less than when dry, but whether the land be heavy or light, wet or dry, it will always require a strong implement and a powerful team to work up the couch-grass with *unbroken roots on unploughed land.* The owner of a hybrid three-horse cultivator will admit that he cannot bring up the whole of the roots, but says that he "gets the greatest part of them out." This may be true enough, but the result of such half measures is, that instead of removing the root weeds by one operation, he does but give a treacherous appearance of cleanness to his fallow, which will induce many an incautious or slovenly farmer to slur over the subsequent cleaning processes, though his land is full of short twitch.

It has been suggested that if a farmer possess a good "cultivator," he requires no other "scarifier." Doubtless a cultivator should be capable of acting as a scarifier on occasion, and the occupier of a small farm would of course not purchase both implements, but after the land has once been thoroughly broken up by an effective cultivator, many of the subsequent operations may be equally well performed by a lighter implement, and the weight which gives steadiness when breaking up hard land, is an unnecessary burden to the horses when the land is rough and loose. A light scarifier would work pleasantly with three, and in some cases with two horses, on a bean stubble or a loose fallow; when a cultivator, which covered no more land, would be quite work enough for four. Both implements therefore have their proper place, and the object of the writer is accomplished if he has succeeded in showing how desirable it is that the names of the implements, the classes in which they are

placed, and the trials to which they are subjected, should all be so clearly and unmistakably distinct, that no man, unless knowingly and with his eyes open, shall be induced to buy one kind of implement when he wants another.

*Harrows* (Judges' Report) —" There were fifteen sets of heavy and light harrows selected for trial. We saw no material improvement in any of them with the exception of a set belonging to Messrs. Howard, of Bedford. They were four beam-harrows with a joint in the centre of each, which allows them to work on uneven places almost as well as where it is flat and level. This, though simple, we considered a valuable improvement, and accordingly awarded them the prize.

" Messrs. Barrett and Ashton, of Hull, exhibited some well-made harrows adapted for heavy work, which we considered the second best."

*Drain tile or pipe machines* (Judges' Report).—" All the machines exhibited, except that shown by Mr. Bullock Webster (who declined competing), were submitted to a preliminary trial of ten minutes each, after which it was decided to test those selected for a final trial, viz., Clayton's, Scragg's, and Whitehead's, by allowing to each a number of turns of the winch, while the machine was producing tiles, so calculated, that the power applied (the hand) should move through equal spaces; an account being taken of the number of tiles produced. A similar calculation was made for the lever machine exhibited by Garrett, and, in default of a more correct gauge, the power required in each case was estimated by the hand of the judges. Tried in this manner, Garrett's machine produced the greatest number of tiles; but in the opinion of the judges, with at least an equal increase of labour; and although the machine is simple and ingenious, and makes good work, they think the application of the lever-bar objectionable, on account of its producing a brief but severe strain, more likely to injure the machine, and requiring greater strength in the man who works it, than the more regular motion of the winch.

" Whitehead's came next in productive power, but did not greatly exceed Clayton and Scragg in this particular; taking into account, however, its great strength and probable durability, the large capacity of the clay-box, which not only permits a greater number of tiles to be made from each filling, but also diminishes the friction of the clay against the sides of the box; the consequent ease with which it is worked, the uniform length and excellence of the pipes, the cleanness and straightness of the cut (most important points, in which some machines were deficient), the judges found that they could not do otherwise than award the prize to his machine.

" The efforts of the machine-makers generally to improve pipe

and tile machines have been very creditable. Clayton's screens, perforated with circular holes, are well calculated to screen clay containing flat slaty stones, which might pass through the screens composed of parallel bars. His machine is the best for making pipes of large diameter, because, being delivered vertically, they descend at once upon the horse; while those made by horizontal machines are apt to fall in and become flattened before they can be supported.

"Scragg has introduced an improved screen through which the clay is forced out on two sides, the bottom, and front of the box; it appears to act well.

"The judges also commend Messrs. Franklin's machine, worked by one horse, for pugging, screening, and moulding at the same time."

No class of agricultural implements has been so rapidly improved of late, as the drain-tile and pipe-making machines. Only five years have elapsed since the Society's meeting at Derby, at which there were but two exhibited, and they excited so little attention, that the bare enumeration of them in the Implement Report of that year was thought sufficient; whilst at York 34 were shown, and it may safely be stated that no description of implement in the yard, with the exception perhaps of the steam-engines, received more patient attention or more ample trial. The writer is therefore glad to have this opportunity of expressing his perfect concurrence in the decision of the judges, and adding a few confirmatory remarks. Whitehead's prize machine is undoubtedly the most complete that has yet been exhibited; but whilst awarding it the praise it so well deserves, it is but just to remark that this maker commenced the business at a time when most of the practical difficulties of the manufacture had been surmounted by the ingenuity and perseverance of others, and that the excellencies of his machine are chiefly the result of principles of construction, previously in use, the merits of which have in this instance become more apparent, in consequence of first-rate workmanship and some additional improvements.

Amongst those who have contributed largely towards bringing the process of tile-making to its present position, the names of Clayton and Scragg deserve especial mention. The former was the first to introduce the practice of screening clay by the same machine which moulds the tile, and his perforated metallic plates are still in high repute for this purpose, being more universally effective, though not so rapid in their performance as the screens made of parallel wires or bars. This maker has also shown great talent in reducing to a system the various processes connected with the preparation of the clay and treatment of the tiles in the

intermediate stages between the pug-mill and the kiln; and his very effective machines have been extensively patronized by the public.

The writer, however, cannot but think that Mr. Clayton would have done well to have discarded the vertical for the horizontal mode of delivery, unless where the production of pipes of *very* large size was an especial object. It is true that these machines may be adapted to either plan, but the one which was tried before the judges at York was worked on the vertical system, so that it is fair to infer that he still considers this the preferable mode, though the decisions of different judges at several successive meetings of the Royal Agricultural Society have been recorded in favour of the horizontal method.

Mr. Scragg has by his numerous improvements been mainly instrumental in developing the great capabilities of the horizontal mode of delivery; and of his excellent machines it is sufficient to say, that they have twice received the Society's prize, and that their form and general principles of construction are nearly identical with those of the prize implement of this year.

After this passing tribute to one or two of the greatest improvers of the machines now under consideration, it will perhaps be desirable to describe rather more fully those properties of Whitehead's machine which obtained for it the prize. Some of its good qualities, such as strength and good workmanship, require no further notice than has already been made of them by the judges, but one of its best points is, the arrangement by which straightness of cut and uniformity of length of tile are secured concurrently with rapidity of production. It is now well known that to produce a straight-ended tile the streams of clay must be cut into lengths when at rest, and to stop the machine for each cut occasions a loss of time. There is also this objection to the plan of cutting off only one length of tiles at once, that the tiles are either not of equal length, or that to make them so a waste of manufactured clay is incurred. In all effective tile-machines, when engaged in manufacturing tiles or pipes of moderate dimensions, several streams of clay are made to issue simultaneously from the die-plate, and no method has yet been devised of preventing a slight difference in the rate at which the clay is delivered from different parts of the plate, so that the streams are never of precisely equal length. This creates a difficulty in cutting them into tiles, as it would be tedious to cut each stream separately, and if without further preparation all were divided by one movement of the cutting wires, the tiles would be of unequal length, and thus occasion additional labour in stacking, as well as loss of room in the kiln. The method adopted has, therefore, been to cut off a

short length of the unequal ends by the same stroke which divides the streams of clay into tiles, thus securing them of perfectly equal length. The unequal ends which are cut off are returned as waste to the clay-box, and it is therefore plain that if but one length of tiles is severed at once, it is no less necessary to cut off the unequal ends, than if, as in Whitehead's machine, five lengths of tiles are divided by one stroke of the wires, and the same quantity of manufactured clay which would in the former case be cut off as waste for making one length of tiles, would in the latter not be exceeded for making five. The practical limit to the number of lengths which can be cut at once is the distance to which the streams of clay can be propelled without losing their shape, and in Whitehead's it was found that, from the size of the clay-box, the strength and power of the piston, and the good construction of the receiver, five lengths of two-inch tiles were made at once without any loss of shape. He has also introduced a second receiving tray underneath the former, and supplied from the same die-plate, the pipes on which are divided by the same movement of the cutting wires which divides those on the upper, so that at one stroke fifty two-inch tiles are cut in the most accurate way, and whilst the boys are carrying them to the shelves the man is refilling the box.

Franklin's machine is most ingenious, and if found on further trial to accomplish its daily task in the tile-yard with *unprepared* clay in the same workmanlike manner in which it did its work at York with clay that had been previously well pugged, it would be a very valuable implement, as by pugging, screening, and moulding at one operation the labour of twice handing over the clay is avoided.

Mr. Bullock Webster, of Houndsdown, exhibited a tile-machine, but was not in a position to have it tried. As this is the second meeting of the Society at which the same thing has occurred, Mr. Webster's attention is particularly called to one of the printed regulations, which provides "that all implements admitted to the exhibition will be liable, on the recommendation of the judges, to be proved by actual trial." The stewards have full powers given them to enforce the regulations, and should Mr. Webster be found to shrink from competition a third time, it is probable that they would not permit the implement to be exhibited at all.

*Carts and Waggons* (Judges' Report).—"Although we awarded the prize for the best cart to John Eaton of Woodford, we wish to observe that we think it far from perfect, and in particular we do not approve of the self-acting tail-board with spring-catch. None of the carts exhibited did, in our opinion, combine the three following points, which we consider essential, viz.:—

"1. Reasonable price.

"2. The body of the cart placed down upon the axle, or as near the ground as will allow the load to be well tilted.

"3. The wheels to run upon a cylindrical rim or trod, the arms or axles being straight.

"The wheels upon the prize waggon are made altogether of iron, and, although they appear strong and good, yet we think that in field work the soil will be liable in wet weather to dovetail over the felloes, and even on grass land with a heavy load they are liable to the same defect."

So much carting is required on every farm in the course of the year, and the expense of horse keep and prime cost of the carts themselves is so considerable, that it is a matter of no small importance that their best form, with a view to durability and lightness of draught, should be clearly ascertained and generally adopted. The Judges found fault more or less with all those exhibited at York; it will therefore be advisable to revert to those principles of mechanics by which their construction was in the first instance regulated, but which are frequently found to have been widely departed from in consequence of the ignorance or forgetfulness of country wheelwrights of the rules by which they ought to be guided. The best form of the most important working parts shall, therefore, be successively considered, and the object of the writer will be to give the results of the mechanical questions involved in the inquiry in language which shall be intelligible to the general reader.

*Form of Wheels.*—A perfectly flat wheel, or, technically speaking, a wheel which is not dished, is the strongest whilst the cart is standing still, or moving on a *perfectly level* road, or, to speak more correctly, it is strongest so long as the cart preserves its horizontal position, because under such circumstances there can be no lateral pressure, and each spoke as it in turn receives the weight of the cart, receives it in a perpendicular position, in which, of course, it is capable of supporting the greatest weight. But in practice carts do not remain stationary, nor are roads accurately smooth and level, and no one can watch a cart travelling on even the best of roads without observing that one wheel or the other is continually rising over a slight elevation or sinking into a trifling hollow, and, consequently, that the cart never preserves a perfectly horizontal position for even a few yards at a time. This is strictly true of a good turnpike-road, but it applies with much more force to farm work, in the course of which carts have to cross ridge and furrow at all angles, and to travel on roads having ruts and holes of all sorts and sizes. It may, therefore, be assumed that a cart when in motion never long retains its horizontal position; and this is a point of the greatest importance, because at each change of level the wheel

which is lowest receives more than its share of the load, and this additional weight is thrown upon it in a way which causes more strain upon the wheel than if a much greater weight were merely placed in the cart, because when one wheel sinks the whole load gives a lurch sideways, and in descending into a deep hole or rut, acquires a certain velocity which at the bottom is brought to a sudden stop, and thus exerts upon the wheel on that side a force which partakes of the nature of impact. It thus appears, that in addition to the vertical pressure produced by the weight of the load, a wheel is subjected to a succession of side thrusts, applied at the axle but resisted at the circumference or rim, which at the instant of any particular thrust may be considered stationary, and is so in point of fact, with reference to any lateral pressure. Having thus determined the nature and direction of the forces which a wheel is required to resist, it will be comparatively easy to determine its proper form. If a wheel be flat, the outward thrust above described is only resisted by the strength of the joints by which the spokes are fixed into the felloes and nave. It is true that in wheels of this make these joints are square, and can be made truer and better fitted than those of any other shape, but, however good the joints, it is impossible for them to stand long when taken at so great a disadvantage. The joints in the felloes especially have the whole leverage of the spoke acting to force them out of their place. The rim resting on the ground is the fulcrum, the side thrust at the axle is the power which is here applied at right angles to the spoke which forms the lever, so that this lateral pressure acts at a great mechanical advantage in forcing the joints, and must soon destroy the wheel if put to rough work. If, however, the wheels be dished, the case is materially altered, as the outward thrust which has a tendency to flatten the wheel is resisted by the convex arrangement of the spokes, which imparts to it in some measure the strength of an arch, and the wheel cannot give way in this direction unless the material fail or the tire be forced asunder. It ought therefore to be considered an established rule in cart-building that, unless for some special object, wheels should be moderately dished; if carried to excess, however, the wheels will be unable, from the slanting position of the spokes, to bear without injury the vertical pressure of the load. This may be obviated by using bent axles, and making the lower part of the wheel perpendicular whilst the upper part leans outwards; but there are many objections to this plan, and it is not at all required if the dishing be not extreme; 1½-inch is found to answer well, and should not be much exceeded.

*Form of Axles, position of Wheels, and shape of Rim.*—These three points are so closely connected that it will be more con-

venient to treat of the whole at once. The most common position of cart-wheels is that above described, in which the lower part of the wheel is perpendicular and the upper part leans outward, the wheels being dished and the axles bent downwards. The consequence of this position of wheel is, that if the tire were flat, or, properly speaking, cylindrical, the wheel would run only on its outer edge, and to obviate this difficulty the rim is made conical, the outer edge forming a smaller circle than the inner, so that the rim meets the ground in a horizontal position. This mode of construction combines so many mechanical disadvantages that it seems difficult to conceive why it should ever have been adopted, and the following is the only plausible reason which the writer has ever heard adduced in its favour, viz., that, admitting the superiority of dished wheels on account of their greater firmness and durability, it is desirable that the inclination of the spokes produced by the dishing should be corrected by the bent axle and conical rim above described, so that the spokes when they receive the weight of the cart should be perpendicular, *i. e.*, in the position of greatest strength. This would be good reasoning if the cart when at work preserved its horizontal position; but, as has been previously shown, this is not the case, and the greatest strain which a wheel has to bear is when it sinks into a hole and has additional weight thrown suddenly upon it. When this occurs, in what position is the wheel placed whose lower spokes were perpendicular when on the level? Clearly the lower part of such a wheel is now too much under the cart, and receives its greatest pressure when in a slanting and therefore disadvantageous position.

On the other hand, a dished wheel running on a straight axle, and, therefore, standing upright, has its spokes in a slanting position when on the level; but the moment it sinks into a hollow its spokes become perpendicular, in which position they are not only able to bear the shock without injury, but have a direct tendency to check the swing of the load. This is very observable with a top load of corn or hay where the centre of gravity lies high, and carts with upright dished wheels may pass with safety where those whose wheels lean much outwards will either be overturned or throw off part of their load. The most serious objection, however, to this mode of construction arises from its adding considerably to the draught. In order that carts, or indeed any kind of machinery, should work without waste of power, the two points to be especially guarded against are, unnecessary friction and a jerking, unsteady motion, both of which defects are the necessary consequence of using wheels with bent axles and conical rims: for when the axles are bent downwards the bushes into which they fit must necessarily have the same

downward slope; the axles, therefore, which bear the whole weight of the cart, rest upon sloping bushes, or, in other words, upon inclined planes, and the result of a weight so applied is that a lateral as well as a vertical pressure is produced, causing, wherever the road is at all uneven, a jerking motion from side to side, which adds greatly to the friction on the shoulder of the axle and the linch-pin.

The defects of the conical rim are equally great, as the natural tendency of a wheel of this shape when rolled on its edge is to revolve round its vertex, and if constrained to move in a straight path it is partly rolled and partly dragged along the road. Wheelwrights are so well aware of this tendency that they endeavour to counteract it by making the wheels look inwards, *i. e.*, placing them so that they are nearer to one another in front than behind; and no doubt this is of use under the circumstances, but it is at best only a makeshift by which an error in one direction is made to counteract in some measure another of an opposite tendency. Few people are aware of the additional and very unequal pressure that is in this way thrown upon the axles, and any one who is interested in the subject may readily test it for himself by removing a wheel from the cart and placing one end of a small crowbar or strong walking-stick in the bush of the wheel, the other end being held in the hand. When the wheel is upright no force is required to keep it so, but if it be placed in a position leaning from the holder of the stick he will find that a heavy wheel will require a strong effort with both hands to prevent it from falling. This represents the extra weight thrown on the axle in consequence of having the wheels in a leaning position. Next, let the wheel be rolled on its edge, whilst the experimenter walks forward in a straight line, and he will find himself sorely puzzled to prevent the wheel from turning away from him by any effort which he can make with his stick, and will thus become practically convinced of the unequal pressure and unsteady action of conical wheels, which in fact are fitted to move only in one direction, but are continually dragged and forced to move in another, producing a great increase of friction and additional wear and tear of material.

To avoid these evils the axles should be very nearly straight, and the wheels consequently very nearly upright. The reason why the former should not be quite straight and the latter quite upright is, that for convenience in greasing, &c., it is universally the practice to make the axles taper towards the end; if therefore the axles were put on *quite straight,* their tapering form would cause them to rise towards their extremities, which would produce, though in a slighter degree, the evils before described as resulting from sloping bushes, the slope in this instance being towards the cart instead of from it. It is very

desirable that the axles which support the weight should rest on a perfectly level bed, and this is accomplished by giving the axles so much bend downwards as to make their under sides horizontal. A slight bend is sufficient for this purpose, but, however slight, it causes the wheel to lean outwards to the same extent. The lean, is, however, so small as only just to throw the balance of weight from the cart, and from having attentively watched carts with wheels in this position working on the same road with others whose wheels were perfectly upright, the writer is of opinion that this slight lean gives greater steadiness to the action of the wheel. However this may be, the other reason for having a slight bend in the axle is clearly an important one, and to bring practice to the support of theory, some carts procured for the writer by Mr. Laurie of Terreglestown near Dumfries, and constructed on precisely the above-mentioned plan, may be quoted as having attracted great attention among practical men, from their true running and lightness of draught; and after seven years very hard work their excellent condition and great favour with the carters who drive them are no bad tests of the correctness of the principles on which they are constructed. The slight lean of wheel above alluded to is not sufficient to make any alteration necessary in the cylindrical rim usual for upright wheels; but from observation of the greater ease with which wheels that have worn down the edges of their tire clear themselves when running in and out of ruts, and with a view to prevent the sucking action that takes place with broad flat wheels on wet land, the suggestion may be hazarded whether a slight rounding of the tire might not be introduced with advantage.

*Height of Cart and position of Shafts.*—Before fixing the height of carts it is necessary to know the average height of the horses which are to draw them, which varies much in different districts; having ascertained this point, the simplest mode of proceeding will be to follow out the line of draught from the point where the shoulder-chains are attached to the collar, to the axle of the cart: in other words, from the point where the power is applied, to the place where the resistance has to be overcome. The first thing to be attended to is, that the shafts should be fixed at such a height by means of the back-band, that when the horse is drawing the shoulder-chain and shaft shall be in a straight line. If the shaft is too high or too low the chain will meet it at an angle, which causes a waste of power. This being done, the shaft will represent the line of traction or draught, and in the remarks which follow, whenever the position of the shafts is mentioned, it must be understood as corresponding with the line of draught. Next, let a vertical line be supposed to be drawn through the axle of the cart, the power will act to most advantage

if applied in a direction at right angles to this line, *i. e.*, if the shafts be horizontal. This holds good so long as the cart meets with no impediments, but when the wheels have to be drawn out of a hole, or over a stone or other obstacle, the power would act with most effect in a direction at right angles to a line drawn from the axle to the summit of the obstacle to be surmounted. Hence it appears that a horse will draw the greatest load on the level if the shafts be horizontal, but that for a pull out of a rut or over a hillock he will have most strength if the shafts slope downwards from his shoulder.

In drawing up hill the case is rather different, and whilst considering this point, it is necessary to bear in mind that a horse ought always to draw by his weight, and that he is assisted in doing this if the cart be so balanced upon its axle that a portion of the load rests on his back. When his powers are severely tasked, as in drawing a load up a steep incline, he ought to be assisted in his efforts by having more weight than common thrown on him; but, in point of fact, the altered position of a cart when ascending a hill diminishes instead of increasing the weight on the horse. This is true of all carts, but the higher they are the more rapidly is the centre of gravity thrown backwards by the elevation of the shafts, and the more quickly is the pressure on the horse's back converted into a lift, which seriously diminishes his power of draught. The argument for and against high carts may, consequently, be stated as follows:—where roads are good and there are few hills, horses will do their work with most ease to themselves if carts are of such a height that the shafts are *nearly* level when the horse is drawing, a slight slope being always advisable in consequence of the unavoidable inequalities of the best roads; on the other hand, low carts are easier to fill, easier to draw on bad roads or over rough ground, and preferable both up and down hill.

On all accounts, therefore, low carts are the best for farm purposes, but those which are intended for road-work alone, where roads are good, may with advantage be made higher; the height, however, should be gained by increasing the size of the wheels, rather than by the ordinary method of placing blocks of wood on the axles.

All that has been here said respecting the height of carts in general applies with additional force to harvest carts, and the inconvenience resulting from their being made unnecessarily high, has led, especially in hilly districts, to the use of waggons for harvest work. The very excellent article * by Mr. Love on the

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* Although the superiority of one-horse carts to three-horse waggons has been completely proved, this simple improvement has not been adopted so generally as to render further proof superfluous. I therefore

use of one-horse carts (Journal, vol. vii. p. 223) shows, however, that it is by no means necessary to use waggons even on the most hilly farms, and it may be desirable to point out that there are two ways by which the inconvenience of a top-load on hilly land may be materially reduced, one of which (as has been already shown) consists in keeping carts *low;* the other, which is equally important, is to make them *wide,* so that a good load may be put on without reaching an extravagant height. Both these points were fully carried out in a useful harvest cart exhibited by Mr. Stratton of Bristol—stand 126, art. 5—and described by him as a Scotch harvest cart-body and shafts, invented by John Morton, Esq., of Whitfield. This was purchased of Mr. Stratton by the writer with a view to testing its merits in the field. Mr. Morton's harvest-body answers remarkably well, but the patent iron wheels are liable to the defect pointed out by the Judges, viz., that when the land is soft, it partly closes over the felloes, in consequence of their being iron, and, therefore, of much less substance than wooden ones. In dry weather or on a hard road they run well. One peculiarity of the harvest-body above-mentioned deserves notice; the frame, instead of having, like common cart-shelvings, two or even three parallel bars of wood at the ends, consists only of one rail strengthened by iron stays. This is found to have an excellent effect in preventing the load from slipping, as the first tier or course of sheaves is bent over this single rail by the weight above, and thus obtains so firm a bite that the cart may have a considerable inclination without disturbing the load; whereas when there are two or three rails, the sheaves in the lowest course lie so flat that without great skill in loading they are very apt to slide when going up or down a steep hill.

*Steam-Engines* (Judges' Report).—"At the trial of the first engine we used only 106 lbs. of coal and 22 lbs. of wood; it arose from the exhibitors having entered the engine as only

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beg to state a plain fact which took place here at the last harvest. Having had my own harvest-home on the 1st of September, I was asked by a neighbour to help him in carrying his barley, which I agreed to on condition that we should try five horses of mine, with five carts, against ten horses of his, with four waggons. The offer was accepted, and it was agreed that the carts and waggons respectively should each take up two swathes of barley, row and row alternately, so that they should perform the same distance, and take an equal chance of any inequality in the crop. The waggons went in first, and with a start of sixty yards. The carts followed, soon passed them, and kept the lead to the end, with half a horse, I should say, to spare. Two good ricks were built up by each respectively, and are now standing here side by side, one the work of *five* horses, the other of *ten.* The carts used were not harvest-carts, as I have only one set, to which rails are added for harvesting.—Ph. Pusey.

requiring 22 lbs. of coal to get up the steam. We gave out this quantity to begin with, but as it did not prove sufficient, the remainder was furnished in smaller quantities as wanted. After the trial of this engine, we determined to give to each exhibitor 22 lbs. of wood and 140 lbs. of coal, with which to get up the steam, and work as long as he could. The tabular statement will show the result. The engines are numbered according to the order of trial."

No. 1.—Stand 67, art. 1.—Exhibited by Edmund Moody, and made by John James Fisher, of Frome.

At the time they were getting up the steam the weather was very much against it. A heavy thunder-storm fell (the boiler not having a case round it), which would no doubt condense a great deal of steam and make it take more coal than would otherwise have been required. Other deficiencies in the engine prevented us from giving it a second trial.

No. 2.—Stand 59, art. 25.—Barrett, Exall, and Andrews.

This engine, like No. 1, took both more time and fuel to get up the steam to the working pressure than was stated in the description: and to find out what it would do in a given time, with a certain weight of coal, was out of the power of the Judges, as Mr. Exall could not keep it steadily at work for above a few minutes at a time. It was also considered altogether too light in construction for agricultural purposes.

No. 3.—Stand 82, art. 2.—William Cambridge, Market-Lavington.

Took about the same quantity of fuel and time to get up the steam as stated in the description; but working 40 minutes, driving 4 horse-power, consumed 70 lbs. of coal, besides what it took to get up the steam. This was at the rate of 105 lbs. per hour; whereas the description stated that 32 lbs. per hour would suffice. A second trial gave a nearly similar result.

It may be well here to remark (as this was the prize engine last year) that though improvements have been made in it since that time, especially in the water-bridge, other defects still remain.

No. 4.—Stand 25, art. 1.—Richard Robinson, of Belfast. (*See* Tabular remarks.)

No. 5.—Stand 22, art. 1.—George Howe, Southwark.

Took 22 lbs. of wood, 120 lbs. of coal, and 75 minutes to get up the steam to 50 lbs. the working pressure, which was more than

Mr. Howe stated in the description, but it will be seen by the Table that when the steam was up the engine did an extraordinary quantity of work with it; for with 20 lbs. of coal it worked (driving 4 horse-power) 50 minutes; thus requiring more coal to get up the steam, but less when in full work than stated in the description. This engine was altogether well fitted, and worked admirably well and steady.

It is very much to be regretted that Mr. Howe had not put a governor to it; by doing so, and making a little alteration in the boiler, we have no doubt the engine would be still further improved.

Mr. Howe's improvements in the transparent water-gauge will be found a useful invention. Every practical engineer has known the want of a flexible packing in the water-gauge, to prevent it from breaking by the expansion and contraction of heat and cold. A *medal* was awarded to Mr. Howe for these improvements.

No. 6.—Stand 37, art. 1.—Messrs. OGG and HOWARD, of Northampton.

Like a great many of the others, consumed more coal and time to get up the steam to its working pressure than stated in the description; however, this engine worked very well. By reference to the Table it will be seen that it took 22 lbs. of wood, 65 lbs. of coal, and 45 minutes to get up the steam, and to work 65 minutes with 4 horse-power it used 75 lbs. of coal, which we consider tells against the use of two cylinders for agricultural purposes.

This engine had a very useful and ingenious apparatus attached to the chimney, called *a spark-catcher,* which acted very well, and cannot be too highly recommended. It had also a governor to regulate its motion. It was the one Mr. Ogg exhibited at Northampton in 1847, and appeared to have been at work for twelve months.

No. 7.—Stand 53, art. 1.—BARRETT and ASHTON, of Hull.

The engine worked quite to the power represented by the exhibitor, with 12 lbs. of coals per hour for each horse-power: but the construction of the boiler was considered dangerous, and the general work of the engine not good; the force-pump ceased working and reduced the water $1\frac{1}{4}$ inches in the boiler.

No. 8.—Stand 24, art. 7.—RICHARD HORNSBY, of Grantham.

The prize was awarded to this engine because it was stronger, steadier, better fitted, got up the steam and worked with less fuel than any other engine exhibited. (*See* Table.)

It worked in every way as the exhibitor has described it. It had a good boiler to generate steam, plenty of cylinder room to

## STEAM-ENGINES.

| Order of Trial. | No. of Stand. | NAME OF EXHIBITOR. | TABULAR STATEMENT taken from the Entry of the Exhibitors. Time to get up Steam. | Coal to get up Steam. | Coal per Hour when in full work. | Pressure of Steam per Sq. Inch. | Diameter of Cylinder. | Length of Stroke. | Revolutions of Crank Shaft per Minute. | Horse Power. | TABULAR STATEMENT of the Trial. Time it took to get up the Steam. | Wood for lighting Fire. | Coals for getting up Steam. | Time the Engine was at work. | Coals consumed while the Engine was at work. | Coals consumed, at the rate per Hour. | Pressure of Steam per Sq. Inch. | Coals per Horse-power per Hour. | Price of Engine. | Price per Horse-power. | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Lbs. | Lbs. | Lbs. | In. | In. | | | Min | Lbs. | Lbs. | Min | Lbs. | Lbs. | Lbs. | Lbs. | £. | £. s. d. | |
| 1 | 67 | E. MOODY, Frome. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | This engine failed to work to the power specified by the exhibitor; the tabular statement is therefore omitted: no governor. |
| 2 | 59 | BARRETT, EXALL, and ANDREWES | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | This engine worked to the power specified, but was so defective in construction that it could not be kept steadily at work: no governor. |
| 3 | 82 | W. CAMBRIDGE, Market Lavington, Wilts | 60 | 90 | 32 | .. | 6½ | 12 | 110 | 4 | 60 | 22 | 70 | 45 | 70 | 93¼ | 50 | 23 | 155 | 38 15 0 | The construction of the boiler not approved of, and the consumption of fuel great: no governor. |
| 4 | 25 | R. ROBINSON, Belfast | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | Construction of the boiler not approved of. The engine also failed to work to the power specified; the tabular statement is therefore omitted. |
| 5 | 22 | G. HOWE, Southwark | 55 | 100 | 35 | 45 | 6½ | 14 | 100 | 4 | 75 | 22 | 120 | 45 | 20 | 27 | 50 | 6¾ | 170 | 42 10 0 | Worked well and consumed very little fuel during its work, owing to its having a jacket round the boiler of a non-conducting material: no governor. |
| 6 | 37 | OGG and HOWARD, Northampton | 35 | 30 | 50 | 45 | two 4¾ | 16 | 110 | 4 | 45 | 22 | 65 | 70 | 75 | 64 | 50 | 16 | 200 | 50 0 0 | This engine had a governor, and a very useful thing, a spark-catcher, but its two cylinders and large consumption of fuel prevented our commending it. |
| 7 | 53 | BARRETT and ASHTON, Hull | 80 | 84 | 75 | 42 | 8¾ | 15 | 110 | 6 | 60 | 22 | 110 | 40 | 40 | 60 | 45 | 12 | 225 | 37 10 0 | The upright cylinder, steam-expanding apparatus, and governor were good, but as a whole it cannot be recommended. |
| 8 | 24 | RICHD. HORNSBY, Grantham | 45 | 84 | 84 | 32 | 10 | 14 | 110 | 6 | 40 | 22 | 73 | 94 | 67 | 42½ | 32 | 7 | 225 | 42 10 0 | In every respect worthy the prize; it was strong and well got up, with a good governor. It fulfilled everything the exhibitor stated it would. |
| 9 | 48 | C. BURRELL, Thetford | 40 | 112 | 50 | 35 | 9 | 15 | 80 | 6 | Withdrawn at the Exhibitor's request. | | | | | | | | 210 | | |
| 10 | 16 | WM. BLOXSOM, Gillmorton | 50 | 84 | 56 | 50 | two 4¾ | 15 | 90 | 4 | 55 | 22 | 70 | 70 | 70 | 60 | 50 | 15 | 180 | 45 0 0 | Well got up and does great credit to the exhibitor; but two cylinders for agricultural purposes we do not think necessary. |

give it power, sufficient strength in all its parts to keep it steady, and an excellent governor to regulate its motion. The only thing deficient was a good jacket to keep the boiler warm.

No. 9.—Stand 48, art. 1.—Charles Burrell, of Thetford.

This engine was withdrawn at the request of the exhibitor.

No. 10.—Stand 16, art. 1.—William Bloxsom, of Gillmorton.

This engine worked very well, and great credit is due to the exhibitor for the pains taken in getting it up. It very nearly fulfilled all the conditions set forth by him in the description, but could not compete with the prize-engine either in quantity of work or consumption of fuel. (*See* Table, p. 408.)

In our opinion, two cylinders are not necessary for agricultural purposes; they make the engine more expensive, there are more parts to be kept in repair, and more attention is required to work them. One objection, however, was obvious, namely, that the slides were placed in such a position that they would with difficulty be got at to repair.

No. 11.—Stand 128, art. 1.—Isaac Tyson, of Selby.

A fixed steam-engine and boiler, rather roughly got up. In consequence of its being a fixed engine, the Judges had no means of testing it.

The price of the two best engines may appear high when compared with some of the others exhibited: but after carefully examining the construction of the boiler, the engine, the materials, and workmanship, we are of opinion that they will be found to be the cheapest engines in the yard to the purchaser.

*Steaming apparatus* (Judges' Report).—"There were four competitors for this prize. In testing them we gave to each 10 lbs. of wood and 28 lbs. of coal, and directed them to get up the steam in the boiler, to bring up to the boiling point about 60 gallons of water, and with the steam keep the water boiling as long as they could with that quantity of fuel. On trial it was found that the apparatus exhibited by John Wood Sharman and Co. got up the steam in the shortest time, and kept the water boiling longer than any of the others: the prize was therefore awarded to it. Richard Robinson of Belfast was so near a competitor, that it was thought right to award him a medal.

The trial of Messrs. Sharman's apparatus showed the following results:—Got up the steam in 15 minutes, heated 50 gallons from 66° to boiling point in 60 minutes, and continued to keep it at that heat for 95 minutes without the steam going down, with the above-mentioned quantity of fuel."

*Thrashing-machines* (Judges' Report).—"In explanation of the

## THRASHING-MACHINES (No. 1).—*Trial with Horses.*

| Stand. | Art. | NAME. | No. of Horses | Diameter of Horse-walk. Ft. | In. | No. of Sheaves Thrashed. | Time. Min. | Sec. | Quality of Work. | State of Grain. | State of Straw. | State of Horses. | Total Revolutions made by Horses. | Feet Horses go over. | Feet Horses go over per Minute. | Price. £. | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87 | 13 | GARRETT . . . . . . | 4 | 18 | 8 | 50 | 5 | 35 | Good . . . | Not injured | Not much broken | Bad horses, hard work | 12 | 672 | 120 | 48 | 10 |
| 87 | 14 | Ditto (Bolting-machine, with Shaker attached) | 4 | 18 | 8 | 50 | 3 | 30 | Quite clean . | Ditto . . | Very good . . | Bad horses, very hard | 10 | 560 | 160 | 61 | 10 |
| 24 | 9 | HORNSBY . . . . . . | 4 | 22 | 0 | 50 | 2 | 33 | Not quite clean | Ditto . . | Ditto . . . | Better horses, hard work | $8\frac{3}{4}$ | 571 | 226 | 85 | 0 |
| .. | 8 | Ditto (Bolting-machine) . | 4 | 22 | 0 | 50 | 3 | 20 | Ditto . . . | Ditto . . | Rather broken | Hard work . . | 8 | 528 | 166 | 42 | 0 |
| 82 | 3 | CAMBRIDGE (Bolting-machine) | 4 | 19 | 0 | 50 | 2 | 20 | Clean . . . | Ditto . . | Ditto . . . | Very hard work | $7\frac{1}{4}$ | $427\frac{1}{2}$ | 183 | 60 | 0 |
| 134 | 1 | DEAN . . . . . . . | 4 | .. | | Broken during trial. | | | | | | | | | | | |
| 64 | 53 | CROSSKILL . . . . . . | 4 | 22 | 6 | 50 | 3 | 30 | Not quite clean | Ditto . . | A good deal broken | Pretty hard . | 9 | $607\frac{1}{2}$ | 173 | 45 | 0 |
| 117 | 1 | HENSMAN . . . . . . | 4 | 21 | 8 | 50 | 3 | 12 | Ditto . . . | .. | Rather broken | Very hard . . | $8\frac{3}{4}$ | $568\frac{3}{4}$ | 117 | 50 | 0 |
| 102 | 2 | ABBEY (Fitted with blowing-machine, riddles, and elevators) | 4 | 22 | 2 | 50 | 4 | 40 | Clean . . . | Ditto . . | Ditto . . . | Pretty hard . | 15 | 997 | 213 | 60 | 0 |
| 53 | 3 | BARRETT and ASHTON . . | 5 | 20 | 9 | 50 | 2 | 45 | Ditto . . . | Ditto . . | Ditto . . . | Ditto . . . | $8\frac{1}{6}$ | 510 | $185\frac{1}{2}$ | 60 | 0 |
| 54 | 1 | HOLDERNESS and GIBSON . | 4 | .. | | Connecting-rod broken during the trial. | | | | | | | | | | | |
| 53 | 2 | BARRETT and ASHTON . . | 5 | .. | | | Ditto | | Ditto | | | | | | | | |
| 69 | 1 | RAWLINGS . . . . . . | 2 | 24 | 6 | 50 | 7 | 45 | Good . . . | Ditto . . | I have made no remark | Very easy . . | 21 | 1543 | 199 | 36 | 15 |

THRASHING-MACHINES (No. 2).—*Trial with Steam Power.*

| Stand. | Art. | NAME. | How many Horses adapted for. | No. of Sheaves thrashed | Time. Min. Sec. | Quality of Work. | State of Grain. | State of Straw. | Power required. | Price. £. s. d. |
|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 9 | HORNSBY . . . . . . . . . | 4 | 100 | 5 7 | Quite clean . | Rather broken . | . . | . . | Price wanted of all the machines where the horse-power is taken away. |
| 53 | 3 | BARRETT . . . . . . . . . | 5 | 99 | 5 27 | Nearly clean . | Not broken . . | . . | . . | . . |
| 82 | 3 | CAMBRIDGE (Bolting machine) . | 4 | 100 | 4 12 | Clean . . . | Not broken . . | . . | Heavy for engines | 30 0 0 |
| 87 | 14 | GARRETT (Bolting-machine with Shaker) | 4 | 100 | 5 9 | Clean . . . | A very little broken | Straight . . | Power not great . | . . |
| 48 | 2 | BURRELL (with Dressing-machine) | 6 | 100 | 9 0 | Quite clean . | Ditto . . . . . | . . | . . | . . |

THRASHING-MACHINES (No. 3).—*Trial with "Force-resister."*

| Stand. | Art. | NAME. | How many Horses adapted for. | No. of Sheaves Thrashed. | Time. Min. Sec. | Quality of Work. | Power required to drive Machine indicated by an instrument attached to the Steam-engine. |
|---|---|---|---|---|---|---|---|
| 82 | 3 | CAMBRIDGE (Bolter) . . . . | 4 | 100 | 6 4 | Well thrashed . | 33½ |
| 87 | 14 | GARRETT (Bolter) . . . . . | 4 | 100 | 5 5 | Ditto . . . . | 28½ |
| 87 | 14 | Ditto (with Shaker) . . . . | .. | 50 | 2 23 | Ditto, and straw straight | 29½ |
| 24 | 9 | HORNSBY . . . . . . . . . | 4 | 100 | 4 59 | Well thrashed . | 32 |

accompanying tabular statement, it will be proper to mention that we commenced by trying all the thrashing-machines by horse-power, allowing the exhibitors the management of their own machines, but from the irregular manner in which sets of horses draw when they are ill assorted and unused to work together, and especially from some sets being much superior to others, we were anxious to try steam-power, and all those machines which thrashed clean at the first trial were allowed, if they wished it, to have a second trial by steam. At the second trial, however, we were still unable to ascertain the power required to drive the several machines; but subsequently, the consulting engineer applied an instrument to the working engine which registered the amount of power required in each case. The results of these successive trials are shown in the tabular statements, Nos. 1, 2, 3. Having thus obtained both the time and the power required by each machine to do the same amount of work, our decision was made without difficulty. The points to which we especially attended during the trial were, 1st, Quality of work; 2nd, Power required; 3rd, Time; which we have arranged in the order of their importance. There are, however, other considerations, such as mechanical arrangement, strength, and good workmanship, which cannot be given in a tabular form. In this part of the examination we were assisted by Mr. Amos, the consulting engineer; and after giving every attention in our power to all the above-mentioned points, we decided in favour of Mr. Garrett's machine. We wish to mention that Mr. Hornsby was unfortunate in the last trial. The sheaves of wheat which we had been using up to that time were finished before his machine was tried, and we were obliged to use sheaves grown in another field and larger than those used in the trials of all the other machines."

The foregoing tabular statement, together with the Judges' remarks would, under ordinary circumstances, have sufficiently indicated the comparative merits of the respective machines; but as Mr. Cambridge has inserted letters in the public papers calling in question the correctness of the Judges' award, it will, perhaps, be satisfactory to him to know the exact grounds on which their decision was made. In the two first trials, it will be observed that his machine thrashed 50 sheaves in 2 min. 20 sec., and 100 sheaves in 4 min. 12 sec., whereas the prize machine took 3 min. 30 sec. to thrash 50, and 5 min. 9 sec. to thrash 100 sheaves; and though it was very observable that Cambridge's machine took much more draught, still, in the absence of any means of registering the power required, it was doubtful whether the great rapidity with which it got through its work ought not to entitle it to the prize. When the force-resister however was

applied at the third trial, all doubt vanished. Mr. Cambridge's man believed that the power alone would be regarded in the third trial; and accordingly fed so moderately that one man less was required to open sheaves for him than in the previous trials. The result was that the machine now took 6 min. 4 sec. to thrash 100 sheaves, though it had previously thrashed the same quantity in 4 min. 12 sec., so that at this last trial it was beaten in point of time by both Garrett's and Hornsby's; yet, in spite of this moderate feeding, the power required to drive Cambridge's machine was represented by the number $33\frac{1}{2}$, which was an increase of 17 per cent. upon that required by Garrett's, without the shaker, which was only $28\frac{1}{2}$. The only fair way of comparing machines of this description is by ascertaining the amount of work performed by each when driven by the same amount of power for the same time; and, when subjected to this test, the three best machines stood in the following order: 1. Garrett's; 2. Hornsby's; 3. Cambridge's.

One defect was observable in most of the thrashing-machines exhibited at York, viz. the small diameter of the horse-walk. There are two reasons which make it important that the horse-walk should be large, the first of which is, that a horse cannot use his full strength when moving in a small circle, as he is placed in a constrained and unnatural position, which prevents his throwing his weight properly into his collar. The second reason is that in a small horse-walk the power is applied at a mechanical disadvantage. The power would be most efficient if applied in the direction of a tangent to the circle, and the smaller the circle is, the more does the line of draught fall within this line, and the greater therefore is the loss of power. Practically it is found that a horse never does his work with ease if he has to walk in a circle of less diameter than 24 feet. It is true that more time is required to make the circuit of a large horse-walk than of a small one, so that the horse-wheel makes fewer revolutions per minute, but this is exactly counterbalanced by the increased diameter of the circle, which makes the arms by which the horses draw proportionably longer. These arms act as levers, and by increasing their length an increase of power is obtained, which admits of the horse-wheel being so much enlarged that its additional number of cogs restores the speed lost by its making fewer revolutions: thus the balance between the power and speed of the machine is unaffected by the change, and its efficiency is increased both from the greater freedom of action given to the horses and the increased angle at which the power is applied. The only set off against these advantages is, that (as has been shown above) a larger horse-wheel is required. There is, however, another mode by which the speed may be regained, viz. by diminishing the size of the pinion which is driven by the horse-wheel, or by introducing an

additional wheel. To judge by the machines exhibited at York, these latter expedients are in much greater favour with the makers than large horse-wheels, but there are serious objections to this mode of construction. Theoretically it is of no importance what combination of wheels is introduced between the horse-wheel and the drum, so that the requisite number of revolutions per minute is ultimately secured, but practically it is highly important that there should be as few separate movements as possible. Wherever an additional centre of motion is introduced, there will be additional friction and *vis inertiæ* to contend with, both of which absorb power. The use of very small pinions is also highly objectionable. From these premises it will at once be perceived how desirable it is that the horse-wheel should be large, as the speed is thus maintained from the first; whereas if this speed be lost in the first movement, it must be subsequently recovered, either by small pinions or additional wheels, the evils of which have been pointed out above. It is urged by the makers, that if the horse-wheels are large in travelling machines, they will not pass through ordinary gates, but a slight exercise of ingenuity would get over this difficulty. The more correct reason probably is, that small wheels are not so costly as large ones, and as the makers do not supply oats and beans for the horses, they are not so sensitive on the subject of increased draught as those who do.

CORN-DRESSING MACHINES.

| Stand. | Art. | NAME. | Price. | Time at Work. | Length of Crank. | Total revolutions in doing the work. | Total Quantity Dressed. | | | | | Total Men required. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Best Grain. | Best Tail. | Tail. | Whites. | Screenings | Driving Machine. | Filling. | Taking away. |
| | | | £. s. | ′ ″ | In. | | B. p. q. | P. q. | P. | Q. | Q. | | | |
| 24 | 11 | R. HORNSBY, of Grantham. | 13 10 | 2 4 | 13 | 66 | 4 1 3 | 1 4 | 2 | 4 | 0 | 1 | 2 | A strong boy |
| .. | .. | Same Machine, dressing same grain second time over. | .. | 1·20 | .. | 43 | 4 0 6 | 0 3½ | 2 | 2 | 1 | 1 | 1 | 1 and a boy |

*Judges' Report.*—"Several other machines were tried, but could not get through the grain, shorts, straws, and chaff, as it came from the thrashing-machines, without being choked or requiring much more time than Hornsby's, which did its work well; parting the whole into best corn, good tail, tail, whites, screenings, and chaff, at the rate of above 15 quarters an hour, and dressing over the second time it did it at the rate of above 20 quarters per hour, parting the whole into six parts, as before, in a workmanlike manner."

*Grinding-mills for breaking agricultural produce into fine meal.*—

The Judges were of opinion that the grinding-mills exhibited did not possess sufficient merit to entitle them to the prize, which was therefore withheld.

*Linseed and Corn-crushers* (Judges' Report).—In this class there were several that did their work in a satisfactory manner. The one shown by Messrs. Sharman received a medal. It worked with greater ease, crushed the seed as well, and faster than any other. They also commended Mr. Nicholson's, of Newark-on-Trent, and Mr. Wood's, of Stowmarket.

*Horse-hoes on the flat* (Judges' Report).—In this class there were none equal to Messrs. Garrett's admirable implement, and although it has frequently before received the Society's prize, we considered it fully entitled to a silver medal. The work done by it is far superior to any hand-hoeing; it can also be done for less than half the cost; indeed, so highly do we value it, that we think no farmer can farm as he ought without having one.

*Horse-hoes on the ridge* (Judges' Report).—A silver medal was awarded to Mr. Busby for his horse-hoe exhibited in this class, which worked very well. Its construction was simple, having a triangular sock in the centre, and two bent knives behind, followed by two sets of rowels on the principle of the Norwegian harrow. These had a good effect in clearing the soil from the roots of the weeds and leaving them on the surface to wither. They also made the hoe run more steadily.

Mr. Harkes, of Mere, exhibited an ingenious implement in this class, having a leverage by which it could be made wider or narrower whilst at work; we highly approved of this invention, with the exception of the shape of the shares, which were all triangular, instead of there being bent knives behind, rather rounded at the corners, to prevent their disturbing the manure in the ridges. Mr. Harkes perseveres in the use of these triangular shares, though their faulty construction has been pointed out to him by the Judges on former occasions. If this alteration were made, the implement might very probably improve its position at these shows.

The Judges also commended a horse-hoe exhibited by Mr. James Kirkwood, of Tranent.

*Norwegian Harrows* (Judges' Report).—Mr. Crosskill, of Beverley, exhibited the best implement of this description, considerable improvement having been made in it since last year: the rowels are fixed on a round axle which makes them less liable to break when they meet with stones, and the instrument is more easily turned—the rowels also are of an improved form, their points being longer and thinner, so as to cut with their edges, which gives them more hold of tough hard clods, and they pulverize the land better and deeper. We had several other implements of different descriptions tried against it, some of which

were spiked rollers, others were Norwegian harrows, constructed on the original principle; but none of them made such good work as Mr. Crosskill's, and we accordingly awarded it a medal. We feel confident that this will be found a very useful implement on stiff clays, to prepare the land for sowing either with corn or small seeds.

*Horse-rakes* (Judges' Report).—Twelve of these were selected for trial, and were first tested as stubble-rakes, straw being strewed about the show-yard for them to collect; after which they were tried as hay-rakes, straw being spread as thickly on the ground as a good crop of hay. The one exhibited by Messrs. Hensman, of Woburn, we considered to be the best, and awarded it a medal; it collected the largest quantity in the cleanest manner, and had the best mode of delivery. Many of the others were, however, very little inferior to it; those especially of Messrs. Howard, Busby, and Grant.

*Grass-land Cultivators* (Judges' Report).—The only one tried was exhibited by Mr. Busby, of Newton-le-Willows. It appeared to answer the purpose for which it is designed, and to clear off the moss and old grass roots in good style. It also by the same operation collects it into rows ready for carting off. All other grass-land cultivators that we have seen, leave the moss, &c. that they tear up, spread over the surface. Where an implement of this kind is required, we think this will prove very efficient. We gave it a medal.

*Haymaking-machines* (Judges' Report).—Out of fifteen that were exhibited, three were selected for trial, and after setting them to spread grass in the swath, and afterwards reversing the action and trying how they could turn that already spread, we were of opinion that Messrs. Smith and Son's, of Stamford, was the best, and awarded them a medal. The particular advantage possessed by his machine over the other two, was in having two steel springs instead of one, to support each of the bars which carry the teeth; the alterations of adjustment were also more readily made in Smith's than in the other two, which were exhibited by Messrs. Grant, of Stamford, and Messrs. Barrett, Exall, and Co., of Reading. The two latter made very good work; but the former appeared to us more simple, and therefore less likely to get out of order.

*Chaff-cutters* (Judges' Report).—The chaff-cutters were first tried by hand, all being set to the same length of cut, viz. 3-8ths of an inch. They were allowed to make 80 revolutions each. The quantity of chaff cut by each is given in the tabular statement. Two of them, Cornes's and Smith's, were tried as litter-cutters, the number of revolutions being noted which each machine made in cutting 20 lbs. of chaff. The large cutters were next tried by

steam, a break being applied to the engine, which limited its action to 2-horse power. The length of cut was, as before, 3-8ths of an inch, and each machine was allowed to work for five minutes, the result being given in the accompanying statement. A medal was awarded to Cornes's implement, and the judges highly commended that exhibited by Edmund Moody, of Frome.

CHAFF-CUTTERS.—1*st Trial* (*by Hand*).

| Stand. | No. | Exhibitor's Name. | Power. | No. of Revolutions. | Length of Cut. | Quantity Cut. | Quality. | Price. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Inches. | lbs. | | £. s. d. |
| 85 | 5 | CORNES . . | 1 Man .<br>2 Men . | 36<br>80 | 3¼<br>3–8ths. | 20<br>25¼ | For litter . . | 14 0 0 |
| 94 | 13 | SMITH . . | 1 Man .<br><br>Ditto .<br>Ditto . | 80<br><br>29<br>20 | 3–8ths.<br><br>2¼<br>3¼ | 19<br><br>20<br>20 | Longer cut than the others.<br>For litter . .<br>Ditto. | 17 0 0<br>If fitted with a litter-cutter, £3 extra |
| 107 | 3 | CORNES, jun. | 1 Man; very hard work. | 80 | 3–8ths. | 12¼ | .. | 12 12 0 |
| 41 | 3 | GILLETT . . | 1 Man . | 80 | 3–8ths. | 6 | .. | 5 5 0 |
| 94 | 15 | SMITH . . | Ditto . | 80 | 3–8ths. | 9¼ | .. | 10 10 0 |
| 72 | 4 | RICHMOND . | Ditto . | 80 | 3–8ths. | 7¼ | .. | 4 10 0 |
| 9 | 4 | GARDNER . | .. | .. | .. | .. | Over-fed . . | 7 0 0 |
| 66 | 4 | HICKS . . | Ditto . | 80 | ¼, its only cut. | 5¼ | .. | 5 10 0 |
| 85 | 4 | CORNES . . | 1 Man; very light. | 80 | 3–8ths. | 7¼ | .. | 6 10 0 |
| 67 | 2 | MOODY . . | 2 Men . | 80 | 3–8ths. | 12¼ | .. | 8 8 0 |

CHAFF-CUTTERS.—2*nd Trial* (*by Steam*).

| Stand. | Article. | Exhibitor's Name. | Power. | Time. | Length of Cut. | Quantity Cut. | Price. |
|---|---|---|---|---|---|---|---|
| | | | | | Inches. | lbs. | £. s. d. |
| 107 | 3 | CORNES, jun. | Steam, equal to 2 horses. | Five Minutes | 3–8ths. | 119 | 12 12 0 |
| 85 | 5 | CORNES . . | Ditto . . | Ditto . . | 3–8ths. | 155 | 14 0 0 |
| 64 | 57 | CROSSKILL . | Ditto . . | Ditto . . | 3–8ths. | 121 | 15 15 0 |
| 94 | 13 | SMITH . . | Ditto . . | Ditto . . | 3–8ths. | 102 | 17 0 0 |
| 66 | 2 | MOODY . . | Ditto . . | Ditto . . | 3–8ths. | 131 | 8 8 0 |

*Gorse-bruisers* (no Report).

*Clod-crushers* (Judges' Report).—The weather was very unfavourable for the trial of these implements: there was, however, no other shown which had any chance against Mr. Crosskill's. The Judges therefore placed it first, and would have awarded it a

prize had there been one allotted to this class. Mr. Crosskill has recently introduced some improvements in the mode of attaching the horses, with a view to apportion the draught more equally between them. This he describes as an equalizing draught rod, with pulleys and chains, for regulating the working of the outside horses, and relieving the one in the shafts. By these alterations the horses are made to draw in a more direct line from the axle, especially where a fore-horse is required.

*Apparatus for steeping, breaking, and scutching Flax.* (Judges' Report).—Mr. Robinson, of Belfast, exhibited a series of new and well-contrived machinery for the above purposes, which was driven by a steam-engine, and worked exceedingly well. A silver medal was awarded to it.

The judges of the *Miscellaneous Department* made the following awards and commendations:—

*Cottage Grates.*—The prize of 5*l.* for the "best and cheapest grate or stove for cottages, combining safety and economy of fuel with effectual warmth and facility for cooking," was awarded to Mr. Nicholson, of Newark-on-Trent. Several other articles of this kind were exhibited, some of which were lower in price. But viewing its neat and substantial appearance, the simplicity and convenience of its arrangements, and the economy of fuel that it seemed to indicate, the Judges were of opinion that it was not only the best, but the cheapest article of the kind shown on that occasion.

*Cake-breakers.*—Mr. Nicholson, of Newark, exhibited a cake-breaking machine on the same principle as the one for which he received a medal last year at Northampton. The Judges on this occasion again awarded it a medal. It is strongly made, and seems capable of executing any quantity of work that can be required under ordinary circumstances, and seems as if, with fair treatment, it would never need repairs. One great advantage belonging to this article is a simple and ready mode of adjusting the rollers, which can be almost momentarily set to admit cakes of any thickness. This consists in shifting the moveable roller by a wedge-slide, which can be fixed at any given point by a thumb-screw placed for the purpose.

*Root-washers.*—Mr. Crosskill, of Beverley, obtained a medal for his Archimedean root-washer. The chief merit of this machine consists in its simplicity and convenience. The roots are delivered into a hopper, and pass thence into an inclined cylinder having two chambers, in the first of which they are confined and washed by turning the handles in one direction; and when thoroughly clean, by turning the handles the other way round, they pass into the second chamber; which is constructed in the form of a spiral, along which they pass until they drop into a spout outside.

*Tank-cleansers.*—A silver medal was given to Messrs. Dean, Dray, and Dean, for their tank-cleanser, which was thoroughly tested by the Judges, and found to perform in a very satisfactory manner. The body of this is simply a liquid-manure cart, and its merit consists in the convenient mode of filling it, which is done by an exhausting pump fixed on the top of the machine, and a flexible hose of large capacity fixed also on the top of the vessel: the hose can be lengthened to any required extent. These contrivances on trial were proved to be capable of conveying into the vessel any matter (or even substance that was not too large for the hose) that is at all in a fluid state. This machine may be of considerable utility in cleansing tanks or cesspools that are not easily accessible, or where the contents are of more than ordinary consistency.

A *Cheese-press* exhibited by Mr. Bruckshaw, of Longslow, near Market Drayton, was considered to possess merit sufficient to entitle it to a medal. It is mounted on a cast-iron bench, and is calculated to give a varied and almost unlimited pressure by merely moving a pin, or roller, into different recesses, which pin acts as the fulcrum to the lever which gives the pressure.

A medal was awarded to Mr. Summers, of Wold Newton, near Bridlington, for his *implement for removing shocks of corn.* This was perhaps the simplest if not the lowest-priced article in the exhibition. It consists of two longitudinal bars like the handles of a sedan-chair, connected by two slots or cross-bars. These slots are fixed in one of the longitudinal bars, and made to slide easily through the other, thus allowing the side bars to expand. These side-bars have iron spikes 6 or 8 inches long on their inner sides, so that, by this simple contrivance, two workmen are enabled to grasp a whole shock of corn, and remove it without disturbing its arrangement. As in most seasons shocks of corn standing on young seeds require to be removed once at least before being finally carried, in order to prevent injury to the clover, this implement, simple as it is, may be of considerable use.

Mr. Blundell, of Theberton-street, Islington, London, exhibited an *agricultural drainage level,* on a new principle, for which the judges awarded a medal. It is simply an angular frame-work of wood, suspended on bearings on a vertical plane, resting on three feet in the usual manner. The sights are on the upper edge of the angular frame, and it is furnished with the necessary screws for shifting the line of view, and fixing it when in the right position. The spirit is contained in an endless tube, bent in the shape of an isosceles triangle; the side or base of which is vertical, and exposed to view. In this vertical side of the tube the spirit rises and falls, close to the edge of an index, and indicates thereon the angle made by the line of sight with the line of true level.

The spirit stands at zero on the index plate when the line of sight is horizontal, and it rises or falls as the line of sight is elevated or depressed. This instrument will therefore be useful for draining, and all similar purposes, as it will not only indicate the true level, but may be set to show any rise or fall per yard or chain that may be required from the place where it stands to any point to which it may be directed.

Many other implements possessed considerable merit, but could not be distinguished by prizes, as the number of these were limited. Several models were exhibited by Mr. Bullock Webster, especially one of a tile-kiln, of a new construction, by which he states that fuel is economised, and the heat, after being used in burning, may be made available for drying purposes. Also the model of a portable drying or "desiccating" apparatus, by which air may be heated and driven by a "fan" into any chamber or other receptacle, and used for drying peat, wood, grain, roots, and other substances.

Mr. Read, of Regent Circus, London, exhibited several fire and other engines, injecting instruments, probangs, &c., of great and general utility.

Messrs. Young and Co., of Edinburgh, exhibited various specimens of wrought-iron railway and field gates, of commendable workmanship and contrivance. Also wire-netting of varied size and form, and unusual cheapness.

Mr. Crosskill exhibited a portable railway, with turn-table, waggons, trucks, and all the necessary appliances, for claying, marling, excavating, or in other ways removing heavy substances. This apparatus might be essentially useful in certain circumstances.

Mr. Henslow, of Holmes Chapel, Cheshire, showed a "reverberatory" churn of recent invention. The principle is new, and requires very little power in the working. The dash-boards are driven by a crank on the axle of the fly-wheel, which gives them a reciprocating, or back and forward motion. It was not considered to agitate the liquid sufficiently, but this defect may perhaps be remedied.

Mr. Hill, of Brierly Iron-works, Dudley, Worcestershire, exhibited a wrought-iron rick-stand, the best of its kind, having that most important merit in an agricultural implement—simplicity, as it has neither bolt nor screw in its whole construction. The iron used is of the T shape, which is the strongest form. The ends of each rafter are turned in the form of a gate-crook, and made to drop easily into holes formed in the flanges of each joist. The rafters being all of equal length, each will fit any place, so that they cannot get out of order, and may be put together in a few minutes by a common labourer. The same exhibitor had a great variety of wrought-iron gates, hurdles, rod

and wire fencing, &c., which have gained for him the prizes and commendations of this Society on former occasions.

Mr. Abbey, of Dunnington, had a combined chicory washer and cutter, a very clever and complete machine of its kind, but it was not deemed to be of such general necessity as to entitle it to a prize.

Several articles and models of importance arrived too late for admission into the Show-yard, and consequently did not come under the inspection of the Judges.

In conclusion, the writer wishes to express his conviction that the trials to which the implements were subjected at York were, on the whole, more complete and decisive as tests of merit than at any former Show, which he partly attributes to the regulations adopted by the Council, at the suggestion of Colonel Challoner, establishing a fixed proportion between the length of crank and the number of revolutions per minute in all hand machinery, and also to the use of a machine for testing the working-power of steam-engines and the amount of draught of thrashing-machines, chaff-cutters, &c. The use of this instrument, and the enforcement of the regulations alluded to have both assisted in placing the machines under trial *in precisely similar circumstances,* and consequently in rendering the decision of the Judges both more easy and more conclusive. The advantage of these methods having once been established, an attempt will probably be made to extend their application wherever it shall be found practicable, and these arrangements cannot be in better hands than in those of the Society's able and zealous Consulting Engineer, Mr. Amos. Whilst enumerating, however, the causes which have led to an efficient trial of implements at the meetings of the Royal Agricultural Society, it would be the height of ingratitude to pass without remark the services rendered by the Stewards of Implements who retired by rotation in 1847 and 1848. Those gentlemen had acted as sole managers of this department for several preceding years, and the writer is able to speak the more decidedly respecting the improvements they effected, from having acted as an assistant-steward at Derby when Mr. Shelley first commenced his stewardship. At that time the increasing extent and importance of the exhibitions of implements were beginning to be felt, but as yet there was such a want of system, especially in the trial of those machines which took place out of the Show-yard, that the public, the exhibitors, and even the Judges were at a loss to know where to go, or what was expected from them. It is by no means intended in these remarks to throw blame on any parties concerned; on the contrary, the greatest anxiety was shown on all sides to carry out the objects of the Society, but it almost necessarily arose from the rapid develop-

ment of this department of the Show, which far exceeded any anticipations that had been formed respecting it, and thus, year after year, rendered insufficient all the previous arrangements. The writer did not again act as steward till the Northampton Show in 1847, and was then much struck with the increased order and method which characterized the whole proceedings, and though it would be folly to assert that the present arrangements are perfect, still a routine has been established which will materially lighten the labours of the present Stewards of Implements, and which entitle Mr. Miles and Mr. Shelley to their best thanks. The long-continued exertions also of Mr. Brandreth Gibbs, and his talents for arrangement, have materially contributed to that excellent disposition of the implement-yard which gives every facility for viewing these apparently unwieldy collections of machines, and has frequently elicited the praise of unprejudiced visitors.

*Moat Hall, November*, 1848.

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## XXI.—*Account of Breaking up Grass-Land by Paring and Burning, at Longworth, Berks.* By Ph. Pusey.

In the last Number of the Journal an excellent farmer, Mr. Woodward, was so good as to communicate at my request a plan by which he had succeeded in growing four heavy crops of wheat in succession from newly broken-up grass-land. It is well known that nothing is more difficult than to secure the first corn crop on such land, and many will not attempt to grow a white crop at starting. The wire-worm, moving about easily in the soil loose with the remaining roots of the grass, often destroys a large part of the plants of corn; and I believe that, besides the wire-worm, the state of the soil itself thus interwoven with a net-work of fibres allows the rising corn to shake itself loose at the root, and so to perish for want of support. Mr. Woodward's plan was to trench the land and bury this loose upper mould. A tenant of my own having dealt with the same difficulty by another process with equal success, I think it may be useful to lay his plan also before the Society, as no one mode of treatment seems applicable to all soils.

The field is of as strong a clay as I have ever seen. It may be said to have no soil—to be all subsoil; and that clay untempered by any grit, so that in dry weather the horseway over it shines as if the ground were polished; and in such weather I have seen workmen endeavouring to dig it for making a road, but obliged to relinquish the attempt, even with the help of a pickaxe.

This field having been drained, the occupier, Mr. Cheer, had the whole pared by breast-ploughing in February, 1846, paying the breast-ploughmen 11*s.* per acre. I need hardly explain that the men push an instrument before them by the knee, paring and turning over a thin sward. On part of the land the sward turned up was burnt; very wet weather prevented the burning of the remainder. It was sown with oats and the produce was as follows:—

| 1st Year. | Quarters per Acre. |
|---|---|
| On land where the sward was burnt . . . . | 6 |
| On ditto unburnt . . . . . . . . . . | 2 |

After the oats were housed in August, 1846, Mr. Cheer informs me that "he agreed to pay 18*s.* per acre for breast-ploughing, and burning the same land again, which the men did on three or four acres; but the ground got so dry and hard that the men gave the job up, until rain fell in October, and then finished breast-ploughing the piece, which, owing to the wet weather, could never be burnt; so that the sward turned up was wheeled together before sowing the wheat, Where it was breast-ploughed and burnt there was a very good crop of wheat; where not burnt there was a very bad one."

| 2nd Year. | Per Acre. |
|---|---|
| Yield of wheat on land burnt, about . | 5 quarters, or 40 bushels. |
| Ditto on land unburnt, about . . . | 5 sacks or 20 ,, |

Mr. Cheer says, that "seeing the good of breast-ploughing and burning in the year 1846, on August 17th, 1847, he again breast-ploughed the field, and burned it over well, at about 8*s.* per acre for breast-ploughing, 10*s.* per acre for burning, including the unburnt sward of the preceding year; half-a-crown for spreading; then breast-ploughing it again in October, in order to cover the seed which was drilled in." The produce just harvested and threshed out was, on the field of 11 acres, $57\frac{1}{2}$ quarters, or—

| 3rd Year. | Per Acre. |
|---|---|
| Yield of wheat on field entirely burnt . | $42\frac{1}{2}$ bushels. |

This last autumn Mr. Cheer again breast-ploughed and burnt the land, obtaining 100 bushels of ashes per acre; and requested my consent to sow it a fourth year with a white crop, a third year with wheat, which I gave, seeing his previous success, on condition of his leaving the land as he proposed two years in clover, to be fed off with sheep on the land.

I now wish only to offer one or two remarks on Mr. Cheer's account of the breaking up of this grass-field.

It seems to me more valuable because it is an undesigned experiment, brought about by the weather, for I knew little of it until two months ago. The account of the yield is by the tenant himself, so that there is no risk of favouritism or exaggeration.

It should be observed that the cost of breast-ploughing and burning, low as it is, need not be regarded as an extra expense, for the land received no horse-ploughing, which on this land may be valued at from 15*s*. to 20*s*. per acre for each time of ploughing.

The object in not horse-ploughing the land was the preservation of its solidity. On so very heavy a clay this may seem a hazardous omission, but the result proved it otherwise.

It is evident that in this old grass-land there must have been a great abundance of vegetable fibre, or the land could not thus have been burnt for four years successively. Old arable-land would not contain enough vegetable matter, and could not be so treated.

The burnt soil evidently acted as a manure; and it is on this very farm that occurred a signal instance of the success of burnt soil, which was published by me in this Journal (vi. p. 477). I have heard of some cases in which burnt clay or mould have failed as a manure, but of many in which that manure has fully succeeded.

*Pusey, Nov.* 29, 1848.

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## XXII.—*Management of Cattle.* By Hall W. Keary, of Longlands, Holkham, Norfolk.

### Prize Essay.

The management of cattle in a country like England must always be a matter of importance, not only to the breeder and grazier, but to the community at large, for upon the successful breeding, rearing, and fattening of those animals the possibility of supplying our daily increasing population with animal food mainly depends. If we notice the scarcity of neat stock which undoubtedly exists in the kingdom at the present moment, it behoves us to turn our attention more deeply to this subject, and to endeavour to ascertain whether improvements in breed and modes of fattening may not assist in some measure to mitigate the evil of so serious a magnitude. It will be my object in the following pages to describe, as clearly as I can, the qualifications of our various breeds, and the several modes of management with which I am acquainted; and, having had for some years an opportunity of observing the management of many different breeds of cattle in various districts of the kingdom, I hope I may not be thought presumptuous in competing for the premium offered by the Society.

I purpose, in the first instance, to notice the three kinds of stock countenanced by the Society, viz., Short-horns, Herefords, and Devons, and will begin with the Short-horns, which have

lately risen very much in importance, and may be fairly designated as holding a high place amongst the large breeds of cattle in this kingdom. The word Short-horn embraces, if I may so speak, more than one race of animals, all no doubt originally descended from the same stock, but displaying, even at the present day, a marked difference in their qualifications. There are the Durhams, or improved Short-horns, and those known familiarly as Lincolnshire and Yorkshire Short-horns, besides which an animal, differing in some respects from both these, is produced in the district of Holderness, in Yorkshire.

The merit of originating the class known as Durham, or improved Short-horns, is due to Mr. Charles Colling of Ketton, in the county of Durham, and during the last few years so much has this kind of stock become appreciated from their aptitude to fatten and early maturity, that nearly all the old breeds previously alluded to have been crossed with the Durhams. To such an extent has this practice been carried, that in almost every fair in the northern and eastern parts of the kingdom, where Short-horns are more usually exhibited for sale, it is a common thing to see droves of this breed, which have been crossed with the Durhams, inheriting from them many of their most valuable properties, and at the same time possessing more lean meat and being of a greater size, thereby giving to the grazier an animal of very great merit.

After the able article on Short-horn cattle by Mr. John Wright, published in the Society's Journal, vol. vii., part i., p. 201, it would be superfluous for me to enter into a minute description of this breed; but I should recommend all those who feel interested in the subject to peruse the paper referred to. The principal herds of Durhams of the present day are those of Mr. Bate of Kirklivington in Yorkshire, the Messrs. Booth, the Earl of Carlisle, Sir Charles Tempest of Broughton Hall, Mr. Whitaker of Otley, the Messrs. Maynard near Boroughbridge, the Marquis of Exeter, the Earl Ducie, Mr. Torr of Riby in Lincolnshire, Mr. Dudding of Panton in that county, Mr. Parkinson of Leyfields in Notts, Mr. J. Beasley of Chapel Brampton, and Sir Charles Knightley, Bart., of Fawsley, both in the county of Northampton.

I believe it cannot be denied, that the dairy is only a secondary object with some Durham breeders; and I fear it must also be admitted, that the best bred Durhams are not, generally speaking, good milkers. The cause of this deficiency I will not now stop to inquire, but I merely state the fact, which I believe is too notorious to be disputed.

For working purposes the improved Short-horns are seldom if ever used, and to submit an animal with such aptitude to fatten

at a very early age to the yoke, would be an unwise and unprofitable expenditure of those qualities, to obtain which so much trouble has been taken and so much cost incurred.

The feeding propensities of the improved Short-horns are well known and almost proverbial. There is something in the very touch of the flesh and silky hair of a good Durham which tells us that the animal must get fat, and in fact forms the grand characteristic of the improved over the original short-horns; and whoever has felt the short, wiry hair and hard flesh of the old Yorkshire and Lincolnshire breed will be sensible of the difference I have endeavoured to describe.

It is, however, necessary to use some caution in this nice point of handling, for even the qualities to which I have referred may be carried to an extreme, and the light fleshed, thin skinned animal ought to be avoided by the grazier almost as much as one of an opposite character. The improved Short-horns possess not only the greatest aptitude to fatten, but they are capable, notwithstanding their large size, of being returned or made fit for the butcher at a very early age. It may perhaps be a question whether the present system of feeding animals so young has not tended in some degree to cause the existing scarcity of neat stock in this kingdom. I shall not, however, enter into this discussion; but it cannot be disputed, that a well-bred Short-horn of the improved sort possesses in an eminent degree every qualification for an early maturity. Short-horns of three years old, or a little more, will often weigh from 80 to 90 stone (of 14 lbs.), and when kept longer and fed for the Christmas market, from 120 to 130 stones is by no means an unusual weight for them to attain.

It is said that Short-horns will not thrive except upon very good land; but, although this observation is to a certain extent true, it does not apply exclusively to this particular breed, as it would in any case be impossible to graze an animal, capable of weighing 80 stones, upon a sheep-walk or rough dairy-pasture; and no matter what its breed, an ox of a large frame ought to be grazed upon pastures of good quality. Besides which, when we look at the immense weight of beef which is annually produced in yards, stalls, and boxes during the winter season, upon turnips and artificial food, the objection which has been urged against the Short-horn ceases to be one of any moment. It is likewise sometimes asserted, that Short-horns consume a large quantity of food; but, even assuming this to be the case, it may be answered that they produce beef in proportion, and, if we examine the facts a little more closely, it may, I am persuaded, be shown beyond doubt, that the well-bred Durham ox does not consume more food than any similarly large animal, and probably not so much. It would, of course, be unfair to compare the daily consumption

of a beast which, when fat, will weigh 70 stones, with that of another which, after being grazed the same number of months, will not weigh more than 50; but if the point were closely investigated and carefully tested by correct experiments, I believe that the balance, putting stones of beef produced against food consumed in a given time, would be greatly in favour of the larger animal. In support of this conclusion, I may adduce the following facts:—The counties of Norfolk and Suffolk, and parts of Cambridgeshire, furnish the chief supplies of beef to Smithfield market for several months during the spring of the year, owing to the system which prevails so extensively in those districts of winter grazing upon turnips and artificial food. Some few years ago the animals bought for that purpose were principally Galloway Scots, both steers and spayed heifers, a breed of cattle which will be noticed more fully hereafter, and which are always considered small consumers; but at the present time the principal occupants of the grazing yards of the above-named counties are Short-horned cattle, not indeed the true-bred Durhams, nor yet the old-fashioned Lincolnshire beasts, but the progeny of the rough Short-horned cows of some of our northern counties, by bulls of the improved breed, from which we may infer that these have proved themselves the most profitable animals to fatten, although perhaps not producing beef of so fine a quality as the polled animals before noticed.

In Short-horns, perhaps, more than in any other kind of cattle, the pedigree of the sire and dam is attended to with the greatest care, and amongst the Durham breeders it is considered a *sine quâ non* that the bulls they use should be well descended, whence extraordinarily high prices have been, and still continue to be, given for Durhams of both sexes, provided they are symmetrical animals, with an unstained pedigree. The Short-horn herd book is well known to every one who professes to breed pure Durhams, and an experienced breeder estimates the value of an animal the moment he learns its pedigree. It is notorious that, from their anxiety to adhere to one particular strain of blood, many Short-horn breeders have injured the size and constitution of their herds, a circumstance greatly to be lamented, as it has produced, in many instances, a delicacy of constitution and liability to disease amongst some of the highest and best-bred Durhams, analogous to which are the injurious effects of a too close affinity in the human system. With respect to crossing, it is found by all experienced breeders that there is great difficulty in doing so successfully from inferior breeds, as, however good the animals may be, unless well descended, no reliance can be placed upon the progeny, and hence frequent failure and disappointment are the result. In the early days of Short-horn breeding there might be

some excuse for this close adherence to one line of blood; but in the present day, when herds are so numerous, it cannot be difficult to obtain a change of good and pure blood. In the larger herds several bulls are always kept, which gives the extensive breeder a great advantage over the smaller one, as he can put every cow to the bull best adapted for the correction of her deficiencies, and it is in this art that the great secret of breeding successfully consists. The Short-horn bulls are usually kept tied up or in loose boxes, and fed upon roots and hay, together with sometimes a little artificial food. They are cleaned, or, to use a stall phrase, groomed every day, and walked round a paddock adjoining the homestead for exercise. The cows in winter are generally tied up at milking and feeding time, and turned into a sheltered straw-yard during the day for exercise. Their food during this period of the year varies greatly in different counties: in some it consists chiefly of hay, in others a proportion of roots is added, whilst in others again a small quantity of meal or linseed-cake is also given. The latter article is said to produce milk and to occasion no unpleasant taste to the butter, if the small quantity of two or three pounds per diem be not exceeded. In summer the cows are kept upon the pastures, and as near home as possible for the convenience of milking.

The age at which the heifers are bulled varies in different herds, some breeders putting them to the bull at eighteen months old, whilst others prefer allowing them to run until they complete their second year, under the impression that their growth is thus promoted and the general system more fully developed. When the time of calving approaches, the cow or heifer is removed from the herd, and in summer placed in a sheltered paddock near the homestead, and in a roomy box in the winter. After calving, if the cow is much exhausted, oatmeal-gruel and warm mashes are given with the sweetest and best hay, and she is only allowed to resume her usual food gradually. Those whose chief object is to rear calves at the expense of the milk allow them to suck their dams for two or three months, and most unquestionably nothing tends so much to promote the health and growth of the young animal, and to fix the future health and constitution of the adult, than a judicious and generous treatment when young. It has been ascertained, that in young ruminating animals the milk passes at once into the fourth stomach, and does not undergo that complicated process of digestion which takes place in adult cattle; and this arrangement points out to us that the food of a calf ought to be liquid, even when it is deprived of its mother's milk. The weaning takes place very gradually, and when new milk can no longer be spared, skimmed milk, thickened with linseed porridge or sago, is substituted; and a few turnips

or carrots cut small, with some sweet hay, are placed in a trough to accustom the young animal to its future food. At six or eight months all nursing generally ceases, and if this occurs in summer time the calves are turned upon young clover layers to pick for themselves. In winter, upon some farms they are kept in well-sheltered paddocks, with a good hovel to run under, and supplied with roots, to which the best hay and occasionally a small quantity of linseed-cake, or miller's offal, are added. In other situations a dry straw-yard, well shedded, makes excellent winter-quarters for the yearling calves. Exposure to wet and cold is very injurious to young stock, and they never thrive well unless comfortably and warmly housed. It is not meant that young cattle should be treated like the stall-fed beast, and almost deprived of exercise, for such a system would be very injurious, and would retard the proper development of the organs of the body—exercise, warmth, and nutritious food of the proper sort being the three most important features in the management of young stock.

As Short-horns attain an early maturity, a great number of the steers are slaughtered at two and a half or three years old. Some breeders prefer keeping them another year, and where there are inferior pastures for them to run over, it may answer very well to do so. The most celebrated Short-horn breeders have, however, such a demand for their bull calves at high prices, that every promising calf, if his pedigree be right, is left uncut; so that the number of steers to be grazed is comparatively small. It is not from the herds of our highest bred Durhams that we must look for a supply of oxen to stock our pastures in summer, or our feeding-yards in the winter, for it is well known that steers of the true Durham kind are seldom if ever exhibited for sale at any of our large fairs, and the breeders of them generally prefer grazing or stall-feeding them at home. It is from the herds of the old Yorkshire and Lincolnshire Short-horns, crossed and improved by bulls of the Durham breed, that the main supply of grazing animals is annually obtained. The breeders in those counties are now fully alive to the importance of kind hair and good flesh in a feeding beast, and the results which in a few years have been produced by judicious crossing from the improved breed are quite astonishing. The difficulty of successful crossing has been alluded to, but those remarks were only intended to apply to animals of pure blood, as there can be no doubt that the most marked improvement almost invariably follows the introduction of a well-bred male animal of good quality into a herd of rough cows. This system is now almost universal in our northern counties, and the old race is fast disappearing. In several districts of Yorkshire and Lincolnshire, as well as in other counties, there are many very fine herds of these improving Short-horns;

and the immense supply of steers and oxen which annually pass into the midland and eastern parts of the kingdom shows the high estimation in which this description of cattle is held. They are purchased by the graziers in those rich fen districts where a bullock of 70 or 80 stone and a sheep can be fattened on an acre, and upon inferior pastures they are frequently grazed during the summer, and then finished in stalls, boxes, or yards during the following winter. Each of the above plans has its separate advocates, and I merely mention them without presuming to determine which is the best. On farms where straw is scarce, stalls in warm hovels used to be preferred; but during the last few years the plan of box-feeding has come extensively into practice; and, like all new systems, is advocated by some of its supporters as being the only mode in which cattle can be properly fattened. In stall-feeding upon the old plan the animals are generally tied up in pairs, and in well-arranged buildings a passage-way is left between the heads of the cattle and the back wall for the convenience of supplying and cleaning out the manger. There are also shutters so contrived as to open and shut according to the weather, in order to preserve an equable temperature, and also underground drains for carrying off the liquid manure into a tank. A feed of turnips or other roots is given the first thing in the morning; the stalls are then cleaned out and the cattle supplied with dry litter. When the morning's feed is consumed, a dry feed of linseed-cake, bean or pea meal mixed with clover chaff or other dry food is then served out. The animal is then left quiet during the forenoon and usually lies down. At noon turnips are again given, and by some the dry feed also as before, repeating it at night; whilst others prefer giving the artificial food only twice in the day. When stall-feeding is managed in the best manner, the animal is well cleaned daily with a curry-comb or hard brush, which tends much towards promoting and preserving its health.

Boxes are generally from 8 to 10 feet square, are separated from each other by three or four strong rails, and have a manger in front divided in the middle, so that the roots and the dry food may be placed in separate compartments.

One of the leading features in this system, and one upon which its advocates lay great stress, is that the manure is not removed as in stalls; fresh straw is daily sprinkled over the box, the trampling of the animals kneads the manure into a solid mass, which frequently remains untouched for several months, and thus is made very fertilizing to any crop for which it is used. Those who practise box-feeding frequently use the cattle compound instead of linseed-cake, or bean or pea meal; and this may be almost considered an essential part of their system. This kind

of food consists of three parts of barley, bean or pea meal, and one part linseed-meal, and is thus compounded:—The linseed-meal is first placed into boiling water, in the proportion of 1 lb. of linseed to a gallon of water, until it forms a sort of jelly—the barley or pea-meal is then added, the mixture being well stirred all the time. The mash thus formed is taken out of the copper and pressed closely into some large vessel in which it will keep several days. It is usual to commence by giving from 5 lbs. to 7 lbs. per day, and the quantity is gradually increased up to 12 lbs. or 14 lbs. Although almost all cattle will eat that quantity with the greatest avidity, it is seldom they can be induced to eat more; turnips or other roots are frequently given with the compound in the boxes exactly in the same way as in the stalls. When the object of feeding cattle is to make a large quantity of straw into manure, open yards, with roomy good sheds, are preferred. From ten to fifteen cattle are sometimes grazed in one yard, but the more they can be divided the better, as they are then generally quieter and less apt to disturb each other. Long bins in which the turnips are given are placed in different parts of the yard; about 3 bushels of swedes per day will generally satisfy a bullock, provided a fair quantity of linseed-cake or other artificial food be added. There is generally a manger in the shed, so that the dry food may be given at any time during wet weather. The times of feeding are very much the same as those described in stalls; and some graziers, in addition to the turnips and cake, give a little long hay at night. If hay cannot be spared, the racks are daily filled with straw; and although this is not very nutritious, it is necessary to give bulk to the food; even cattle eating turnips will voluntarily consume several pounds of straw daily. The water of the turnips being soon separated, straw is necessary to enable the complicated digestive process peculiar to herbivorous animals to proceed properly. Without bulk of food they cannot ruminate, and rumination is necessary to keep all cattle in health.

Having described the three systems generally pursued in winter-feeding cattle, it may not be amiss to stop for a few minutes to inquire into their respective merits. The advocates of stall-feeding assert that the temperature can be better regulated in stalls than in yards; that each animal can eat his share undisturbed; the removal of the manure daily they consider more healthy for the beast than when it is allowed to remain under him for several months; and they also contend that the animal when tied up and deprived of exercise fattens quicker. In boxes the animal is said to be more comfortable and contented, to thrive faster, and the manure to be undoubtedly very superior. In open yards provided with comfortable sheds the bullock is treated more in conformity with his natural habits, and, being a hardy

animal, he will seek shelter whenever it is required or is necessary for his comfort.

Whichever plan may be adopted, I believe one or two very simple rules are applicable to each :—Warmth, that is shelter from wind and rain, cleanliness, a good lair, quiet and undisturbed repose when the animal is disposed to take it, and, as far as practicable, supplying the food in small quantities, carefully removing out of the bins or mangers all soiled or rejected food. Salt in moderate quantities is much relished by cattle; it promotes digestion and is productive of health.

The females of the crossed Short-horns, which I have before alluded to, are in great request; and on examining the extensive dairies around London and other large towns, we shall find a large proportion of Short-horn cows. These are free from the objection which is urged against the high-bred Durhams as to milk, and are found to produce perhaps the largest quantity of milk per day of any breed in existence. The quality of their milk, it is true, is not so rich as that of the Ayrshire, the North Devon, and the Alderney cow ; but, in the dairies alluded to, quantity and not quality is the great object sought to be attained. The arrangements in these establishments are worthy of notice. The cows, several hundreds in number, are kept in stalls tied up by the head, and are never turned out for any purpose. The utmost cleanliness prevails, and the animal is regularly brushed and cleaned like a horse. Hay forms a considerable portion of its food, but roots and grains are used for their milking properties.

The Holderness breed, which requires to be noticed as one of the Short-horn class, strongly resembles the old Yorkshire, except that it is larger and rather lighter of bone, and altogether a better fleshed animal. It has been asserted that they were originally brought from Holland. The cows of this breed are profuse milkers, and used to be eagerly sought after by the London dairymen. They have, however, latterly been much crossed by the Durham bulls ; and the old-fashioned Holderness cow is far more rarely to be met with than formerly.

The Herefords, which are sometimes called the rivals of the Short-horns, are principally found in Herefordshire, parts of Shropshire, Worcestershire, and Breconshire, and on the borders of Radnorshire and Montgomeryshire. There are also large and valuable herds of them in many other counties, but chiefly in the hands of noblemen and gentlemen. The colour is red, with a white or mottled face, the horns long and turning upwards, the hair smoother, shorter, and, if anything, harsher than that of the improved Short-horns, whilst the hide is generally thicker. In a well bred Hereford there is also no want of good flesh and

handling, though we miss that rich mellowness of hair and skin which is almost peculiar to the improved Short-horns.

Amongst the most celebrated Hereford breeders may be mentioned Mr. Thomas Jeffries Pembridge, near Leominster, Herefordshire; Mr. W. Perry of Monkland, near Leominster; Mr. J. N. Carpenter, Eardisland, near Leominster; Mr. Thomas Lockley Meine of Cound Arbor, near Shrewsbury; Mr. John Thomas of Cholstrey, near Leominster; Mr. Samuel Aston of Lynch Court, near Leominster; and Mr. Thomas Sheriff of Coxall, near Brampton Brian, Herefordshire.

For dairy purposes the Herefords may be generally considered as inferior to the Short-horns; for although the latter are too frequently deficient in their milking properties, especially some of those of the highest blood, there are numerous instances of Short-horns being good milkers in herds, where that quality has not been lost sight of.

It cannot be denied that taking the Herefords as a breed they are inferior milkers. The dairy is little thought of by the generality of their breeders; and in many instances the calf consumes the greatest part of the milk.

Hereford cattle are not much used for working purposes in their native districts, but are occasionally put to the plough in other localities, when they are found to be both useful and docile.

For their feeding qualities few breeds can be compared with them. It is true that they do not arrive at such early maturity as the Short-horns, and that the latter animals, under a similar course of keeping, are as forward at three years old, or a month or two over, as the Herefords at four. This part of the question however is of more consequence to the breeder than the grazier. The immense number of Hereford cattle, both steers and oxen, which are annually purchased by graziers in different parts of the kingdom, proves the high estimation in which they are held. It is chiefly in the midland counties that they are grazed and fattened upon those rich pastures, for which that part of the kingdom is so celebrated. Herefords are rarely seen in our northern counties; nor are they frequently to be found in the eastern districts. The average weight of a grass-fed Hereford is from fifty-six to sixty-six stones; but when stall-fed, and kept longer, they will weigh considerably more.

A good ripe Hereford ox sells well in Smithfield market. It has more meat on the roasting-joints than perhaps any other description; whilst the meat is also fine in the grain, and the offal light. With these excellencies, however, it is generally admitted that a fat ox of this kind shows every pound of beef which he grows, and that he rarely cuts up for the butcher any better than was expected.

The Hereford breeders prefer their cows to calve in November and December, and generally speaking the calves are introduced to their dams both morning and evening, and in many instances they take all the milk. When the season arrives for turning out to grass, it is not unusual to allow the calves to accompany the cows. The calves thus wean themselves gradually, as they soon learn to eat grass, and are quite strong and able to pick for themselves long before winter. From the time of weaning little or no difference may be said to exist in the treatment of the young stock, between the Short-horns and Herefords. Warm and well-sheltered paddocks with hovels, or yards with open sheds, form in both cases their winter quarters, in which they are supplied with hay, roots, and, generally speaking, a rather liberal allowance of cake or other artificial food. This treatment is often repeated to a certain extent the following winter, and amongst no description of cattle are the young steers kept in such high condition as the Herefords. At the Hereford October fair a great show of steers and oxen in almost every stage are exhibited for sale. They are purchased for all purposes, many being considered fat enough for Smithfield market, others requiring six or eight weeks stall-feeding to top them up, whilst the youngest and those lowest in condition are purchased for straw-yard or grass wintering.

There is a good deal of fashion observed amongst the Hereford breeders; some look very much to colour, others to symmetry and quality of flesh; and I believe all are too much addicted to the system of close breeding, and too great adherence to their own stock.

The graziers of our midland districts usually purchase their Hereford oxen either at the great Hereford, or subsequent local fairs, held in the autumn, for wintering upon their rich grass-lands, where they are liberally supplied with hay, and have open hovels to run under; or they winter them in straw-yards, and give four or five pounds of linseed cake daily.

In early spring the Hereford cattle again make their appearance at many large fairs in the Midlands (Northampton, Market-Harborough, Daventry, Lutterworth, &c.), the remainder of the stock required for the summer being then bought in. Those wintered are generally the most forward in condition; even if not, having entirely recovered from the effects of drift, &c., they are in a state to be put forward, and usually take precedence during the summer (according to the season and quality of the pastures): these are fit for market towards the middle of July or the beginning of August. Thus, when the grass begins to shrink, the grazier is enabled to ease his pastures, and put his less forward bullocks into better keeping. These again make

room either for a third succession, intended for yards in winter, or grass and hay; or for a lot of West Highlanders, or North Wales runts, which are turned in to follow the feeding beasts. As the autumn approaches it is a good practice (adopted by some graziers) to give their fatting bullocks a small quantity of good hay early in the morning, even on the best pastures, and particularly if the season should prove wet and cold; nothing tends more to correct the watery nature the grass begins to assume at this season, and to prevent scouring and other ailments. By the time the first lot is finished the rest are ready in turn for the London market, which until the early part of November is supplied with grass-fed beef. About this time the grass frequently loses its quality, and those bullocks that are not then fat are taken into the stalls to be finished off.

In some grass districts, where roots are scarce, hay and linseed cake, or meal is used; but where turnips or mangold-wurtzel can be procured they are given in the manner already described.

Besides the pure bred Herefords, it is not unusual to see crosses from them with the old smoky-faced cattle, now rarely met with in their purity, except on the borders of Shropshire and Montgomeryshire. This description is eagerly sought after, and is considered to produce deeper fleshed bullocks than the Herefords,

For grazing purposes the Hereford oxen are almost unrivalled, but still that can hardly be called a profitable animal to breed, which, when young, consumes nearly all the milk supplied by its dam, and requires eight or ten months longer to bring it to maturity than other cattle of equal weight.

The Devons, chiefly produced in the county from which they take their name, are an extremely hardy race of animals, although the natives of one of our mildest and most southern counties. As with the Short-horns, so amongst the Devons a great difference is perceptible in the same breed; and cattle of the like colour, and similar characteristic marks about them, nevertheless differ most widely in their feeding and milking properties. The pure North Devon, of a somewhat dark-red colour, with long soft hair, and kind flesh, white nose, bright prominent eye, indented forehead, and rather long and tapering horn, possesses as great an aptitude to fatten as any description of cattle in the kingdom; and when its carcass is placed upon the butcher's stall few can equal the quality of the beef. Very different, however, are some of those animals, which have been very aptly termed red-bullocks, with horns (the only marks of the Devon breed about them), which are frequently exhibited for sale at our eastern and midland county fairs as Devon oxen. These cattle have large bones, coarse strong hair, short thick heads and horns, with hides as

thick and flesh almost as hard as a wall; and speaking from experience, I know no animals more unprofitable to graze either on pastures or in yards. They are sometimes designated South Devons, and are to be met with in Cornwall and in parts of Somersetshire, as well as in Devonshire. It is from their experience in cattle of this description that many graziers, who have never tried the right sort, are heard to condemn the Devons as unprofitable stock for the farmer to purchase. Amongst the most eminent breeders of pure North Devons may be mentioned Mr. George Turner of Barton, near Exeter; Messrs. Quartley of Molland, Devon; Mr. Thomas Fouracre of Durston, Somersetshire; Mr. Thomas Umbers of Wappenbury, near Leamington; the Earl of Aylsford, and the Earl of Leicester of Holkham.

Besides these two descriptions there is another of a mixed breed, a cross between North Devon bulls and the cows of the rough animals just described. In many instances the produce is very good, and some most useful cattle of this sort may frequently be purchased at the large Devonshire fairs in the spring.

The richness of Devonshire cream and butter is almost proverbial, and although the North Devon cows are not great milkers, yet the quality is so good, they will produce almost as much butter per cow as most other breeds.

The general average of Devonshire dairies is one pound of butter per day for each cow during the summer months, or as long as they are well kept, and some of the best will occasionally produce more.

Though accustomed to the fertile pastures of their native country, the Devons will bear transferring to inferior soils, and to colder and more exposed situations, without suffering in the slightest degree. Thus upon the bleak coast of Norfolk, and upon light and inferior pastures, North Devon cattle are found to thrive remarkably well, and to sustain their flesh upon very indifferent keeping.

For working purposes the Devons are unrivalled; and no description of cattle with which I am acquainted can be at all compared to them, either for quickness of step, endurance, or pluck. There is almost as much difference in working between a Devon ox and other breeds as we find in the light, cleanly, active cart-horse, and the heavy, hairy-legged, sluggish dray-horse. For feeding purposes the pure North Devons possess every qualification—kind flesh and lightness of offal; and although they do not attain the great weights of some other breeds, they will fatten at a very early age. They may be made quite fit for the butcher at from two years and three months to two and a half years old, and will at that age weigh from forty-four to fifty stone (14 lbs. to the stone). If kept to three years old, or a

little more, they may easily be made to weigh from fifty to sixty stone.

The Devonshire breeders generally bull their heifers at from 20 to 24 months old, and regulate their keep according to age. The dry cows are kept very badly in winter upon straw and a little rough grass, or upon indifferent hay, but even with such keeping they maintain themselves in very good condition. Those well in milk are allowed a few roots. From their naturally strong constitution they require little or no nursing after calving; the calves are allowed to suck their dams a few days, after which a little new milk is generally allowed for a fortnight, this is gradually lessened and skim-milk substituted. A little oatmeal, carrots, and turnips are given as soon as the calves will eat them, and they are thus weaned by degrees. When turned on the pastures all nursing generally ceases. I believe the Devons from being more hardy are, generally speaking, worse kept than any other stock.

The oxen are put to work at from two to three years old, according as they are wanted, and worked until five or six, when they are fed quickly. Four young and two old bullocks are required to plough an acre per day upon heavy land, but upon light soil they will do more. In Devonshire they are always worked in yoke.

In Norfolk, Devon cattle are extensively used in the plough, but invariably two abreast, and with collars like horses. Four bullocks are generally allowed to work one plough, two being used in the forenoon from six o'clock to eleven, and the other from one o'clock to six. In this manner they plough generally 1½ acre per day upon turnip soils. It is, however, no uncommon thing for three seasoned bullocks to work one plough, and if well kept they will do it without difficulty all through the spring. When the weather becomes hot, a bullock suffers very much if he is worked longer than five or six hours. In hoeing ridged turnips or mangold-wurtzel with a single hoe, two steady bullocks, one at a time, will walk over 5 acres per day; but to do this they must work rather longer than the usual time, namely about eleven hours instead of ten: for this work I prefer them to horses; after a little practice they are easily managed, turn at the ends without trouble, and scarcely injure a single root.

The period at which the working Devons are fattened varies greatly. A favourite old bullock is frequently worked too long, and it then requires both additional time and quantity of food to make it fat; generally speaking a certain number are fed off each year, and fresh ones are bought and broken in to supply their place. These old working oxen when well fed attain to a great weight, frequently from 84 to 90 stone; they are, however, im-

mense consumers, and will devour, when first put to turnips, 5 or 6 bushels daily besides artificial food.

For certain districts the Devons must be considered most valuable animals, being hardy and easily kept, upon poor soils, in the driest summer and upon the most scanty herbage. Their rich milk and fine quality of flesh, combined with their unrivalled working qualities, are becoming more appreciated than formerly, and they are gradually increasing in importance amongst our native breeds.

Having now described the three breeds of cattle countenanced by the Society, I shall briefly notice a few others which still exist in different districts of the kingdom to which they are almost peculiar. Amongst these may be mentioned the Sussex cattle, which are seldom seen except in their native or the closely adjacent counties. They are very large animals when fully grown. There are a few good herds of them in Sussex which have had no cross of blood for 100 years. The cows are not good milkers, nor do the best breeders think much of the dairy, strong constitution for work, with an aptitude to fatten afterwards, being the points principally attended to.

The general rule is to wean the calves at about four months old, after which they are frequently very badly kept for the first few years. Most of the steer-calves are brought up for work and are broken in at two and a half years old, and worked till seven; they are then turned off to fatten, and make very fine oxen at Christmas, weighing from 70 to 80 stone. Oxen are very much used in Sussex for agricultural purposes, and with the exception of the Devons they are, perhaps, better adapted for it than most other breeds. They will not, however, fatten at an early age, and hence the reason they are now so rarely met with.

In some of the dairy districts of Leicestershire, but more particularly in Warwickshire, the Long-horn cattle are still to be found. In the days of Bakewell they were more in repute than at present, being taken up by that eminent sheep-breeder, and he had, at one time, some very good animals of the sort. The Long-horns are extremely hardy cattle, capable not only of enduring exposure to inclement weather, but thriving upon poor cold grass-land, better than many other descriptions. They are very much in favour in the Warwickshire cheese dairies, and their milk is said to abound in curd much more than in butter. Certain it is that the cheese made in those districts is remarkably good, and the butter quite the reverse. The cows are invariably bulled, so as to calve in early spring, and thus afford the longest time for cheesemaking upon the pasture land. The calves are taken away almost immediately, the steers frequently sold, or if kept, reared at as little expense as possible.

In summer the cows after milking are driven to their pasture, which is frequently changed, and they are not allowed to remain in the same field many days together. In winter they are generally dry, and oat-straw, with a little rough hay, frequently forms their only food. When the cows begin to fail as milkers they are sold to graziers in the neighbourhood, and upon some of the rich grazing-grounds of our midland counties they become very good beef. With the exception of a few herds in the hands of noblemen and gentlemen, the steers of the Long-horn breed are seldom reared, and consequently a drove of oxen of this sort is rarely seen. Short-horn bulls have been recently introduced into some of the herds so that the pure Long-horn cattle are daily becoming more scarce.

In Norfolk and Suffolk the polled cattle, known in those counties as homebreds, were very common some years ago. In Norfolk the genuine sort are now rarely seen; the breed having been so much crossed by Short-horn and other bulls. Their milk is poor in quality, and they are, generally speaking, light-fleshed animals, not possessed of great aptitude to fatten, although the beef is said to be of remarkably fine quality. In some parts of Suffolk polled cows are still common on small dairy farms; they are very hardy, and esteemed for the quantity of their milk.

The cattle of the Channel Islands, generally passing under the name of Alderney, are chiefly valued for the richness of their milk; they are quiet and docile, and when kept for dairy purposes only, in mild and unexposed localities, useful animals. They are, however, light fleshed and bad feeders, and are therefore little used in this country, except in the dairies of noblemen and gentlemen. In the first part of the fifth volume of the Society's Journal will be found a most full account of the Jersey cow by Colonel Le Couteur, of Belle Vue, in the island of Jersey, and it would be merely repetition on my part to do more than thus notice it.

As the native cattle of the Principality are usually brought up in large numbers to be fattened upon our English pastures, I presume that I shall not be departing from the objects which this Society has in view, if I proceed to make some observations upon them.

The North Wales cattle are generally considered the best and most sought after by the English grazier. Those called the Anglesea are black with long horns, turning upwards and outwards, short on the leg, wide carcasses and hips, and with good hair and handling, in short possessing in many points a strong resemblance to the West Highland Scot. They thrive well on the Kent and Essex marshes, and upon the rich grazing grounds of Leicestershire and Northamptonshire, and will weigh when

fat from 40 to 50 stone. They are not such good milkers as many of the Welsh breeds, and are seldom if ever put to work.

The smoky-faced Montgomeryshire cattle are, perhaps, the most important and valuable amongst the native breeds, and are reared principally in the vale of Severn. They are good milkers and kind feeders, and when crossed, as they are now becoming, with the Herefords, produce a race of animals which is held in the highest estimation, as it possesses in a great degree the aptitude to fatten of the Hereford, and also retains from their original stock a depth of flesh, quantity of lean meat, and proof when slaughtered in which the pure white-faced breed is frequently deficient.

The South Wales cattle may be divided into three classes: First, the Pembrokeshire; Second, the Glamorganshire; and Third, the mixed breeds of Carmarthenshire, Cardiganshie, and the western parts of Breconshire and Radnorshire.

The first of these, the Pembrokes, are generally of a black colour, varied occasionally with white spots, and white along the belly; the horns are of a medium size, yellow, and gracefully turning upwards; the head small and fine, and the eye bright and prominent. Their chief defects are too great a length of leg, flatness of rib, and want of width across the loin. The oxen will weigh when fat, at four years old, from 50 to 56 stones (14lbs. to the stone). They are moderately good milkers, and the average weekly quantity of butter may be stated at 6 lbs. a cow through the grass season. The Pembrokes are excellent workers, being tractable, active, and hardy, and are therefore much used in the plough. The best specimens of this breed are to be found in the hundreds of Castle Martin and Roose.

*Second.* The Glamorgans are of various colours, red, brown, and black, intermixed with white. They are coarser than the Pembrokes, have the rump set on too high, and are inferior in early maturity. They are good for the pail and excellent workers, and the oxen will weigh when fat from 56 to 64 stones.

*Third.* The mixed breeds of Carmarthenshire, Cardiganshire, and the western parts of Brecon and Radnorshire, generally exhibit no uniformity of character, being the result of crosses with the above breeds and with those of North Wales. Some of them are tolerable milkers, yielding from 8 to 10 quarts at a meal; but generally speaking they are small, light-fleshed animals, with short wiry hair and but little propensity to fatten, and seldom attain a higher weight than from 36 to 46 stones; they are never used for working purposes.

In the cattle of the upper districts of Cardiganshire, and the hills of Radnorshire, a marked improvement has taken place of late years, since the introduction into the country by the Duke of Newcastle of the Kyloes or West Highland Scots.

The management of the dairy throughout the Principality exhibits nothing remarkable; and breeding and rearing are conducted upon no particular system. In the choice of their male animals the Welsh breeders are very careless; and if a bull be a sure stock-getter, all other deficiencies in him are entirely overlooked. The cows, too, are more valued for their milk than any other quality—and, in fact, that is too often the only qualification attended to. The calves are weaned at all ages; from ten days to six weeks. They are then fed on skim milk or gruel, with the addition in some instances of small pellets of barley-meal, peas, &c. As soon as the grass is sufficiently forward, they are turned into some small enclosure, where they remain until autumn; and after a run over the stubbles they are put upon a short allowance of hay, which carries them through the winter.

Much negligence is exhibited in the manner in which yearlings and young stock are generally wintered. They are either exposed to the cold winds and storms of the mountains, or, if housed at all, are huddled together in close, dark, ill-ventilated hovels, and entirely deprived of exercise, which is so essential to growing animals. Open straw yards are almost unknown, and the manure, when removed from the hovels, generally lies scattered about in small heaps, to be dried by the sun and washed by the rains.

But few of these cattle are grazed in their native country; the greater portion being driven to the richer pastures of England, where they are fattened upon one or other of the systems already described.

The northern part of our island has long been famous for its breeds of cattle; and it is frequently a matter of astonishment to see the immense droves which annually pass the Scottish border from their native hills to the rich pastures of a more fertile district.

The Galloways, or, as they are frequented called, polled Scots, constitute one of the most important native breeds of Scotland. They are reared most extensively in the Lowland districts, and are considerably larger than the Highland Scot, with less hair, and with greater milking properties; although the quantity of milk is not great, it is rich in butter. When of the right sort the Galloways are quick feeders, especially the spayed heifers, of which a considerable number annually find their way into England. A good Galloway should have a long kind head and thick chine (in the latter point many of them are very deficient). plenty of long soft hair, and the best of flesh under it. It has been remarked, and with considerable truth, that the Galloways which come southwards are not so good as formerly; and instead of the animal just described, there are too many to be seen of a very opposite character—short, thick heads; thin, bad chines; short, wiry hair;

and no handling about them. There cannot be a worse sort of bullock for the grazier to purchase; they never grow an inch, and for months it is very difficult to say whether they are better or worse than when first put to keeping.

The Galloway breeders generally bring up their calves from the pail, and keep them well till they are a year old; from one to three they frequently lie out all winter, having a little rough hay on the sward. They are generally fed off, in their native districts, from grass, when rising four years old. Those brought into this country are chiefly purchased for winter feeding in stalls or yards; for the latter they are peculiarly well adapted; from being a hornless and naturally docile animal, they lie remarkably quiet, and disturb each other very little; they weigh when fat from 56 to 64 stones. It has been before observed that they are not so much sought after as formerly; and in the eastern district of the kingdom of late years they have been very much supplanted by the Short-horns.

The Ayrshires are of two distinct sorts: the Native breed, a small, light-boned animal; the Dunlop Ayrshire (a cross between the Native breed and the Holderness) is a much larger description of cattle; the cows are frequently bought by the Edinburgh and Glasgow dairymen, being excellent milkers. The small breed is considered of the best quality. The calves are reared from the pail and housed in winter; they feed tolerably well, but are rather light-fleshed animals, and do not reach heavy weights. They thrive on moderate pastures, and are considered a hardy race of stock. There are herds of Dunlop Ayrshires, as well as of the Native breed, in many parts of this kingdom, principally esteemed for their excellent milking qualities and general hardihood; and by good keeping the steers may be returned at an early age, and when between two and three years old will reach from 46 to 50 stones.

The West Highland breed is remarkable for its great hardihood and for the peculiarly fine flavour of its flesh when fat. The oxen are brought southward, in the latter part of summer and autumn, in immense droves, and find their way into almost every district in the kingdom. They are generally purchased by graziers to gnaw or eat up the rough fog or aftermath left upon their pastures by feeding cattle during the summer, and for this purpose they are invaluable. In the most severe winter, assisted occasionally by a little rough hay, in a deep snow, the West Highlander will work its way, and keep its flesh in a most surprising manner. For milking purposes the West Highlanders are of little or no use; and, in fact, are seldom, if ever, milked in their native hills. The characteristics of a good and well-bred West Highland Scot are long and somewhat large horns, turning up-

wards and outwards, the tips of which are of a dark green or black colour, plenty of long soft hair, thick back, and a deep good carcass; the prevailing colour is black, but dun and yellow are not uncommon, and the latter very frequently prove the best feeders. The breeding-cows are drafted and bulls put amongst them so that they may drop their calves in April and May. The calves invariably follow and suck their dams till the autumn, when they are separated from their mothers and put into some sheltered situation, such as rough woodland, which has been saved for wintering. They have also a regular supply of hay daily. Stirks or young stock rising two are treated in the same manner: at a year and a half old some breeders sell them to those farmers who make a provision for wintering cattle. Others who have large farms, well sheltered, and plenty of hay, keep them until rising three. It is very seldom that any of the cows are milked, and scarcely any of the stock housed in winter, with the exception of a few late calves. They are generally fed off upon grass rising four, or sold to the English drovers. After eating rough grass, &c., in this country, during the first winter, they are generally, in the following summer, grazed and finished in the pastures; if upon good land and well kept during the spring months, they may be sent to market in July or August, and according to their frame will weigh from 36 to 46 stones. When not finished upon pastures, they are generally stall-fed, or boxed, and seldom put into loose yards. Highlanders rarely do any good in that way: they are naturally so wild and fretful, the partial confinement proves irksome, and they are continally poking and goring each other. If there is no convenience for tying them up in stalls, it is better to give them a little cake upon the grass land (from 3 to 5 lbs. per day), beginning about the middle of July, or whenever the grass begins to shrink, and, if necessary, continuing it until late in the autumn, if the season be favourable, adding a little good hay the first thing in the morning, when the days begin to shorten, and the nights become cold. Under the above treatment, if the grass-keeping is only moderately good, Highlanders will do remarkably well, and infinitely better than in yards. Even in stalls they sometimes progress very slowly, at first, for many weeks, and it is evident they were never intended for such close confinement. It is highly necessary, in the treatment of our domestic animals, to study, not only their food, but also the habits given them by nature; and any attempt to thwart them will generally end in disappointment.

The Fifeshire breed, chiefly black, with horns, is a strong-boned race of cattle, rather deficient in flesh, and frequently bad handlers. They are not much in repute across the border, and are principally fattened in their own country. The calves are brought up

by the pail, and kept in loose hovels or sheds in winter ; run upon inferior pastures afterwards ; and are fed off rising four years old in stalls or loose hovels, and weigh upon an average from 56 to 60 stones.

The Aberdeenshire breed is very similar in many respects to the last, but possesses a better aptitude to fatten and a greater thickness of meat on the roasting joints. They are treated in a similar way to the Fifeshire, being fed off at home, principally in winter, rising four years old, and weigh from 60 to 64 stones. The females of both the last-named are only indifferent milkers.

The Angus breed is both horned and polled. The horned ones are a cross between the best West Highlanders and the Aberdeenshire : they have short legs, a deep carcass, and are generally speaking good handlers. They feed more quickly and cover better than the Aberdeenshire, and weigh from 56 to 60 stones. They are reared and fed in the same manner as the two preceding breeds.

The polled Angus are generally speaking very inferior to good Galloways, although there are a few herds of this breed which have been greatly improved lately. They want hair and lean flesh, and are often bad handlers, and slow feeders. They are treated like the last, and will weigh about the same.

### *Diseases.*

Although it is not my intention to enter here into a minute detail of the diseases of cattle, yet there are some which come so closely under our daily observation that it may be necessary to notice them briefly.

To the breeder there is none more distressing than that well-known, and too often fatal, disorder, called puerperal or milk fever in cows. Many die of this complaint, which is generally produced by the animal being too fat at the time of calving, or from improper force and violence being employed at the time of delivery. This malady has been hitherto little understood. It was formerly supposed that the womb was the seat of the disease, but it is now the opinion of the most eminent veterinary surgeons that the brain and nervous system are its principal seats. It sometimes destroys life in a very few hours, and I believe in the majority of cases it proves fatal. The question, then, arises, as milk fever is seldom cured, how it can best be prevented. I believe cows kept in the field are much less liable to it than when they are tied up, or closely confined, in summer. If the animal is in very high condition, and the weather hot, bleeding ten days or a week before calving, and a reduction of the diet is highly necessary. Exposure to severe wet and cold in winter with very low diet, such as straw or bad hay, is quite as likely to produce disease as the opposite treatment in summer.

### *Red Water.*

This disease, detected by the dark colour of the urine, also frequently proves fatal. There can be little doubt that the primary cause of it is improper feeding, producing a disordered state of the digestive organs. It is said to be peculiar to particular soils, growing certain sorts of herbage, but it is frequently known to follow a period of long drought, and to attack cattle suddenly removed from poor mossy pastures to others of different quality.

The treatment principally consists in opening the bowels by purgative medicine, and afterwards giving some mild cordials.

### *Slipping Calf.*

There are few, I believe no animals, so liable to abortion as the cow, and there have been frequent instances on particular farms where it has prevailed almost like an epidemic, running through a whole herd of perhaps twenty cows, and continuing for several years. Various causes have been assigned for this disease, such as feeding on improper food, want of exercise, impure water, sudden fright, &c. It is highly important, when a cow slips her calf, that she should be immediately removed from the herd, for if other pregnant cows smell the offensive matter, frequently left behind, they are almost sure to do the same. Unless the animal is of great value, it is by far the most prudent plan to feed her directly, for a cow that has once slipped her calf is very likely to do it again, and thus perpetuate the disease.

### *Hoven or Blown.*

This disease is generally caused by over feeding on rich luxuriant pasture, especially in moist or wet weather. The usual remedy in slight cases is to drive the animal about, and to administer some active stimulant, which frequently gives relief. When, however, the symptoms are more severe, there being much difficulty of breathing with great distension of the stomach, it is better to use the trochar, an excellent instrument made expressly for the purpose. It should be struck into the left side of the animal, midway between the first rib and the hip, and about five inches below the loin. The shield of the instrument remains after the trochar is withdrawn, through which the gas escapes. After this operation it is as well to change the pasture for a day or two, and give a mild aperient.

### *Foul in the Foot or Low.*

This lameness occurs principally to fattening oxen. It consists in soreness, and a discharge of matter between the claws. The usual remedy is to pull a hair rope backwards and forwards several times, and afterwards dress with some mild caustic; in

all common cases this generally succeeds. In cases where the symptoms are more severe, and when the disease does not give way to simple remedies, it is better to take the advice of the veterinary.

### *Lice.*

Lice is generally the effect of bad keeping, and may be cured by a strong decoction or infusion of tobacco. Blue ointment is sometimes used, but it is attended with some danger; generally speaking, the first mentioned remedy will be found sufficient.

### *Epidemic,*

Or, speaking of cattle, more properly, epizootic diseases, have been very prevalent during the last few years. That which first made its appearance is now so universal that, like the measles or hooping-cough in the human subject, all cattle are almost expected to have it once in their lives, and although they may be, and are, frequently attacked with it a second and even a third time, it is seldom so severe as in the first instance. The symptoms are a profuse discharge of saliva from an ulcerated mouth, with intense lameness, the feet, between the hoof and heels, being affected similarly with the mouth. The animal refuses to feed for several days. Amendment then begins to take place; and with the exception of a dose of salts in the first stages, and rubbing the mouth with a little common salt, I believe the less that is done the better. If the season admits of it, the animals are better kept upon grass land than upon straw. This disease seldom proves fatal, but causes great loss of flesh and milk. When it subsides cattle generally thrive remarkably fast for some time afterwards.

### *Pleuro-Pneumonia*

Is a more modern disease, and only became known amongst us six or seven years ago. It is by far the most fatal scourge which has appeared amongst cattle for a great length of time, not unfrequently sweeping off fifteen or twenty cows and oxen from one herd, and sometimes apparently defying all that veterinary skill can do to arrest it. It is generally supposed that the seeds of this disease lurk for some time in the animal before any outward symptoms are displayed, and hence it becomes so difficult of cure. Attention is generally first attracted to the beast by its leaving the herd, standing with the head pushed forward, refusing to feed, and, if moved, emitting a short husky cough. Having unfortunately witnessed many cases, and having tried various remedies, I shall proceed to give an account of what has come under my own observation.

In the autumn of 1845, a drove of sixty West Highlanders were

purchased at Falkirk fair, and driven direct into West Norfolk. A week after their arrival they were divided into three lots. Those most forward in condition were put into a straw-yard, and fed upon turnips with a small quantity of linseed cake. The others were equally divided: one lot was turned into some fresh-water marshes upon the coast, and the remainder were driven to a grass-farm 14 miles inland. A fortnight after Christmas the pleuro broke out, first amongst the forward cattle in the yard, and in a very few days afterwards in both the other lots. A skilful veterinary surgeon was called in, who tried various remedies with very little success; and out of the sixty only twenty-eight escaped the disease or recovered. Many of the best beasts were slaughtered so soon as the symptoms exhibited themselves; and from subsequent experience of this fatal malady I do not hesitate to advise the use of the knife at once, if the animal be anything like beef. Pegging the chest was thought useful to some of the poorer cattle; but a large proportion in each lot fell victims to the complaint.

The chief fact worthy of observation in the above account is, that notwithstanding the almost immediate separation of the original drove into three different localities, and the difference of their treatment, yet the pleuro appeared in the same form at nearly the same time, and attended with precisely similar symptoms in each of the lots. We must therefore, I think, conclude that the germ of the disorder had been lurking in their system ere they reached their destination, and that whatever may be the original cause of the malady, whether it be atmospheric or otherwise, it is too often contracted, and has already made deep inroad on the constitution before we are aware of its presence, or have the opportunity of applying a remedy. Take, again, another case. In the following autumn thirty more West Highland cattle were brought upon the same farm, and about a month after their arrival were attacked with pleuro. They were all in low condition, and not ready for the butcher, and it was determined to try the cold water remedy. The moment a bullock betrayed symptoms of the disease he was removed from the pasture, placed in a roomy, well ventilated box, and covered with several horse-rugs thoroughly saturated with cold water. Over these rugs several dry sacks were thrown, and 4 oz. of spirit of nitric ether were administered in a quart of cold water. The same dose was repeated in half an hour; and in five or six hours afterwards, the wet clothes being removed, plenty of dry warm clothes were put on, and allowed to remain for several days. If the symptoms did not abate, 2 oz. of the ether were administered every day. The only food which the animals were permitted to have was some thick gruel, made by dissolving powdered linseed cake in boiling

water. The above treatment was tried with very small success, and out of twenty beasts which were attacked, fourteen died, some sinking rapidly, and others lingering for weeks in a most deplorable state. Upon a neighbouring farm I had, in the course of the same season, the opportunity of observing the same remedies tried, with a more fortunate result, on ten or twelve Short-horns, five out of six of which recovered, and made very good beef. Whether the pleuro which attacked the Short-horns was a milder form of the disease or not I cannot say, but several other instances have come under my observation, in which the remedies described have been attended with great success, and I consider them worthy of notice. Veterinary surgeons are not at all agreed as to the original cause of this disease, or as to what is the best and most successful mode of treatment, and I fear it is a scourge which will still continue to thin the herds of our cattle.

Having now endeavoured, to the best of my ability, to carry out the instructions of the Society, in treating of the management of cattle, I propose to conclude with a few general remarks, which are the result of personal observation and experience.

It may be laid down as a general rule that the climate and soil of any locality, where it is intended to raise a herd of cattle, should influence the decision as to the breed of animals to be selected. The particular purposes, too, for which they are required, should have due consideration, as it has been shown that in almost every breed some peculiarity exists. In the choice of females it will often be found difficult, and indeed almost impossible, to obtain such as are altogether desirable. The breeder who is willing to sell a first-rate bull calf will on no account part with any of his best heifers. It is therefore chiefly in the selection and application of the male animals that the breeder must depend upon for improving his herd. This is of course a work of time, and requires both patience and skill to bring it to a successful issue; but when we observe the satisfactory results which have been produced by this system in some breeds of cattle, no one ought to be discouraged by the above-mentioned difficulty.

In the selection of a male animal of any breed whatever, it is highly important to trace, if possible, the different qualities for which his ancestors have been remarkable. It is well known that the good or bad qualities of the dam of the sire are almost invariably imparted, in a greater or less degree, to his progeny; and not for one generation alone is this the case, but it may frequently be traced through a long line of blood. In nothing is this training back so clearly shown as the manner in which colours will break out, even in remote generations. Having decided, then, upon the qualities we wish to see predominate, let the male animal be chosen from a family possessing them. If milk is de-

sired, a bull descended from a cow that is a good milker should be used; and the same as to other properties.

The difficulty of combining fattening and milking qualities in the same animal is generally felt and acknowledged; but is it a law of nature that this combination cannot take place? The principles of physiology forbid us, I think, to affirm that such is the case; and the fact of a cow producing a large quantity of butter is a proof that her food is readily converted into fat; besides which, it is a matter of frequent experience for deep milking cows, when, from age or other causes, they are dried, to grow rapidly into fine carcases of beef. By studying more closely the habits of our animals, and paying due attention to those qualities in the selection of the males, I cannot help thinking that the valuable combination of milking and feeding properties may be attained.*

These remarks will be found to apply in an equal degree to strength of constitution and general hardihood. '*Fortes creantur fortibus*' is an old axiom; and the descendants of delicate or diseased animals, however healthy they may appear, will rarely beget stock possessing sound constitutions. Temper, too, is a matter of considerable importance, as it invariably runs in families; and no fretful, irritable animal is ever a good milker or quick feeder. One conclusion to be drawn from these facts is, that even in small herds it can rarely be a right practice to use only one bull. Perfect animals are seldom, if ever, met with; and it is in the correction of each other's deficiencies, by matching the male and female properly, that improvements can alone be effected.

Although some breeders contend for the system of in-and-in breeding, my observations of its effects on different races of animals impels me to an opposite conclusion; and although I believe that the use of strong and healthy males may in some degree modify the evils and preserve soundness of constitution,

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* On this point I have the experience of my herd of Devons, which has been carefully managed for at least fifty years. I can show abundant proofs of this desirable combination. The attainment of this double object is the work of years, and of constant attention. The rule is, never to rear the calves of the offspring of a cow which has proved but an indifferent milker or a bad feeder; nor to buy a bull of which you are unable to trace the *true* pedigree and the qualities of the mother. It is most difficult to ascertain these points from the breeders of bulls for sale, and it is therefore best to buy a bull whose stock has been proved before he is introduced into a good herd, however correct he may be in form and to the touch. In purchasing cows, it is essential to try to obtain the knowledge of the observation of the herdsman, at any cost, to guide the judgment, because at some seasons the animal may be unjustly condemned or approved by the cursory observer.—PORTMAN.

and that close-breeding deteriorates the milking more than the feeding propensities of the stock, yet of one thing I am fully convinced—namely, that if the system be long persevered in, *size* cannot be maintained. This important quality being lost, all other excellencies are of little avail; for what can be worse than the small, stunted, and therefore useless and unprofitable progeny of a naturally large race of animals?

The treatment of milch cows will materially influence the quantity and quality of their milk; and the judicious use of roots and artificial food in moderate quantities during the winter months generally yields a liberal return. It is, however, extremely important not to overload the stomach, or give anything which may cause indigestion; for so intimate is the connexion between the stomach and udder, that the slightest disorder in the former is immediately communicated to the latter, to the injury of the milk. Small quantities of food given frequently are, I believe, more conducive to health and the production of milk than an unlimited and constant supply of roots, hay, &c. &c. The quality of the water is also a matter of great importance and one which is frequently overlooked, if we may judge from the filthy compounds which some cattle are allowed to drink. They are frequently watered at a dirty horsepond adjoining the farm-yard, contaminated by the excrement of cattle and the drainage of dung-heaps. Can it be doubted that so impure a liquid must produce disagreeable effects on the milk in the first place, and eventually on the health of the animals? A liberal supply of pure water, especially during the hot summer months, is highly conducive to the well-doing of milch cows. During pregnancy I have no doubt great injury is often inflicted by the use of improper food, such as bad, mouldy, or mow-burnt hay, large quantities of straw, &c., unmixed with other substances of a more nutritious nature.

Derangement of the stomach and digestive organs has a general influence on the constitution of the animal, and in a state of disease the fœtus cannot be properly nourished, and a stunted puny progeny must be the result. From repeated trials I am quite convinced that nothing can supply to the young calf the loss of its mother's milk for the first three or four months, and I believe it will well pay in many instances to provide foster-mothers, making one cow bring up two calves at a time. A calf reared in this way will be stronger, larger, and healthier than another, two months older, deprived almost immediately of new milk, no matter what other substitutes are supplied.

The various systems of feeding have been described, and the different descriptions of food upon which cattle are fattened. It is, however, more important by far than either food or mode of

supplying it, to select animals possessing feeding qualities, without which all our efforts will prove unsatisfactory.

Not being prepared with any experiments sufficiently detailed for insertion here, as to the value and feeding qualities of different sorts of food, I shall merely state in general terms the result of my own observations. I am, moreover, by no means satisfied that any single experiment, or even a series of them, are or ought to be at all conclusive when we examine practically the difficulty of the question they are required to decide. For instance, suppose six oxen are taken to test the effects of two different modes of fattening: three to be treated upon one system and three upon the other. How difficult it is we all know to select six animals from any drove, however large, possessing in the same degree equal and similar qualifications; and hence the difficulty—I may almost say impossibility—of deciding fairly by any experimental results. Two out of the six oxen may be diseased and unable to digest properly, and cannot consequently assimilate their food. In many trials, which have been made to test the value of different roots, &c., so far as I am aware no conclusive results have been arrived at; in some instances being in favour of one article of food, and in some of another. A close and careful observation in our daily practice of the different effects of food and treatment is, I think, more likely to lead to correct conclusions than a too great reliance upon experiments which manifestly must always be conducted under a considerable degree of doubt and uncertainty.

A moderate quantity of roots (turnips in winter, and mangold-wurtzel in the warmer weather of spring), combined with a limited portion of artificial food, will prove more fattening than an unlimited supply of both. From 2½ to 3 bushels of swedes, and 2 bushels of mangold-wurtzel with from 7 to 10 lbs. of linseed-cake or meal per day, of various sorts, mixed up in cut hay, I usually find sufficient for the generality of bullocks. If a little long hay can be spared it is a valuable addition, as encouraging the proper process of rumination and thereby promoting and preserving health.

It would be absurd and unprofitable to attempt to lay down any precise rule as to what sort of artificial food should be used; and it appears to me that they who attempt to decide peremptorily on this matter are apt to forget one important point, namely, the relative prices of these different descriptious of food. When linseed-cake is at a high price and grain at a low one, it will naturally occur to the consumer to use the cheaper commodity; and thus, in certain seasons and under peculiar circumstances, that system, which might be a profitable and a proper one to adopt, would, under a different state of things, prove wholly inapplicable.

The production of the greatest quantity of beef in proportion

to the food consumed is the chief object to keep in view; nor should we lose sight of other important qualities, but endeavour to produce animals possessing the aptitude for obtaining a fat carcass with a well filled udder.

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## XXIII.—*On Draining with Fir-boughs.* By Lord Portman.

My dear Pusey,—I have much pleasure in complying with your request that I should send you the particulars of my experiment of draining with Scotch fir boughs. In 1824 I drained a large meadow near the Stour, at the depth of 3 feet, at distances of 24 feet, and filled the drains with Scotch fir boughs cut in June and July, laid longitudinally in the drains, filling the drains 18 inches thick. I filled up the remaining 18 inches of the drains with the earth taken out, and covered them with turf. The subsoil is a stiff clay, fit for making bricks. I had occasion last winter to make a cutting across the meadow, and I found every drain that I crossed in full work and the boughs of the fir still sound, and indeed harder than the fresh-cut fir. I observe in Mr. Webster's Essay on the Failure of Deep-draining, published in the last number of our Journal, that he quotes me as telling him of an instance of failure on an estate of mine near Blandford. This is not quite correctly stated, and if you think fit you may print the particulars of the case to which, I suppose, he refers. In a conversation with Mr. Webster, at No. 12, Hanover Square, I stated to him some facts connected with an attempt I had made to drain some stiff clay on blue lias at Bickenhall, in Somersetshire, which facts tended to show the danger of systematic draining according to any fixed rule as to the depths of and spaces between the drains.

In that district I had tried drains at different depths and of different distances, from 2 feet to 10 feet deep, from 3 feet to 20 feet apart, and four months afterwards I saw the water standing by the side of each drain just as it stood on the undrained lands adjoining, almost on the surface, within one foot from each drain. I drained in 1844 a field in that district as an experiment, at 31 inches deep, 20 feet apart, and I have this year examined the land and found it as dry as in such a season is possible; and as I have had four years' experience of this trial, I am encouraged to go on with my attempt to drain that land, having patience to wait adequate time for the opening of the pores of the land by tillage, &c. I am more and more convinced, by experiment and observation, that no rule can be safely fixed for the depth and distances of drains. I think that in each case it would be wise to make experiments prior to the engaging in any large work of

draining, having regard to the strata of the earth as well as to the sources of the supply of water. I think it is wise to try to find the depth at which the water ceases to be able to sink perpendicularly, and then tries to pass away horizontally, but being unable to do so, rises again and by accumulation fills the land. Having found *that* depth, art should aid nature and supply the conduits at that point to lead the water away. The distances between the drains should be determined also by pits dug at different spaces from the drain that is formed, in the mode which has now become a tolerably general practice. With these data and some patience I should carry on the works with full confidence of ultimate success.

Yours truly,

*Bryanston, August* 29, 1848. PORTMAN.

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## XXIV.—*On the comparative Merits of Thick and Thin Sowing.* By R. BIRCH WOLFE.

IN the middle of a field of 50 acres, sown with wheat in the last autumn, two pieces of land, of 5½ roods each, were marked out for drilling; one at 9 inches, with 6 pecks per acre; the other at 7 inches, with 7 pecks per acre.

The two pieces were as accurately drawn out as possible, and if there was any difference in the quantity of either piece of land, it was in favour of that drilled at 9 inches. The lands adjoined each other, and had for many years past been farmed exactly alike. The seed (Spalding wheat) was drilled the same day, and was of the same quality.

The produce of each plot was reaped the same day and bound by the same men, and was carefully set up in shocks of 12 sheaves each; and there proved to be 5 shocks, or 60 sheaves, more from the 9-inch than from the 7-inch drills; but to ascertain the quantity of grain, without the inconvenience of setting apart the whole produce, 20 sheaves were taken indiscriminately from each parcel of land, and immediately carried home and threshed; and from the result, as given below, it would seem that thin seeding and wide drills may be carried to a very prejudicial extent.

9-INCH DRILLS.

| SEED per Acre. | Number of Sheaves. | Produce of 20 Sheaves. | TOTAL assumed Produce of the 5½ Roods. | Produce per Acre. |
|---|---|---|---|---|
| | | Bush. pk. qts. | Qrs. bush. p. | Qrs. bush. qts. |
| 6 Pecks | 996 | 1 1 2 | 8 1 1 | 5 3 6 |

7-Inch Drills.

| SEED per Acre. | Number of Sheaves. | Produce of 20 Sheaves. | TOTAL assumed Produce of the 5½ Roods. | Produce per Acre. |
|---|---|---|---|---|
| | | Bush. pk. qts. | Qrs. bush. p. | Qrs. bush. qts. |
| 7 Pecks | 936 | 1 2 4 | 9 4 0 | 6 3 5 |

Balance in favour of the narrow drills, 7 bushels and 7 quarts per acre.

The greater number of sheaves produced by the wide drills can only be accounted for by the greater size and strength of the straw, which, however, produced ears very little superior to the rather weaker but more numerous stems from the 7-inch drills.

It should also be stated that the 9-inch drills had the advantage of being once well hoed, which the 7-inch drills had not.

*Wood Hall, near Newport, Essex,*
1 *Sept.* 1848.

Note.—I have formerly tried many experiments on sowing both wheat and rye upon light and heavy land, on a large farm in the North of Germany, and always found that thick sowing was best on the light porous soils, but on clays thin sowing was better, and dibbling best of all—whether drilled or broadcast—both in the saving of seed, the quality, and the quantity of the crop. This, however, only applies to wheat, as rye is, in that country, seldom sown in any other than poor, sandy soils.—J. F. Burke.

A series of experiments for many years in the same district is required to settle the question in such district. In one large district it is found best to sow 2 bushels of seed in drills 9 inches apart, and that is there the general system. In another more or less seed is required, dependent on climate, soil, elevation, exposure to wind, game in more or less abundance, birds, insects, &c. No one rule is good for every district. The increase in these cases of Mr. Wolfe, estimated by the peck, is nearly twenty-seven fold. The increase of each individual grain that produces corn is, in the generality of seasons, from 120 to 150 fold, as I have proved by counting the grains in an immense number of instances. Is it not worth while to consider the causes of this great difference and at least apparent loss to the farmers?—Portman.

## XXV.—*The Farming of Devonshire.* By Henry Tanner.

### Prize Report.

### *Extent and Population.*

This county contains, according to the late trigonometrical survey, 1,654,400 acres of land, of which 1,200,000 acres are arable, meadow, or pasture, and 454,400 acres remain in an uncultivated state.

The population, by the census of 1841, was 533,731, of whom

a large proportion are employed in agriculture. The following is a correct analysis of the population, as to their modes of occupation:—

| | Professions and Trades. | Agriculture. | Domestic Servants and General Labourers. | Independent. | Paupers. | Residue.* |
|---|---|---|---|---|---|---|
| Devonshire . | 13· | 10·2 | 10·1 | 3·8 | 1·4 | 58·8 |
| England . | 16·9 | 7·7 | 10·4 | 2·8 | 1·1 | 58·9 |

Thus, it appears that whilst the agricultural population is $2\frac{1}{2}$ per cent. above the average of England, the professional and trading portion is nearly 4 per cent. below it; but this deficiency is supplied by a larger number of persons of independent property. The mining operations are very limited in extent in this county, and employ only 1411 persons, of whom 265 are under twenty years of age.

### *Surface.*

In considering the agriculture of this county it is necessary to bear in mind its physical peculiarities, as these present themselves to our notice in a very prominent manner, and materially influence the rural economy of the district. The surface varies much, being in general a frequent succession of hill and vale, but occasionally of a more level character. Numerous rivers and tributary streams flow through these valleys, adding much to their beauty and providing an ample supply of water, which may be judged of from the fact that there are the extrordinary number of 330 county bridges. The principal rivers are the Exe, Teign, Dart, Tamar, Tavy, Axe, Plym, and Torridge, all of which are to some extent navigable, and 26 others of lesser importance.

### *Climate.*

The agencies which influence climate are numerous; some are apparent and their effects can be correctly anticipated; others are less evident, and their influence subtle and obscure to a degree that baffles the intelligence of man; and these are more observable in the climate of Devon than in that of any other part of the kingdom. In order to afford some data by which we may more intimately examine the character of the climate of Devon, I have given the following Tables, containing the most satisfactory observations which have been published on the subject.

* Under this head are comprised all those whose occupations are not specified. They are principally youths under twenty—females and infants.

TABLE No. 1.—Devonshire.

| | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Mean of the Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature . | 39°·42 | 42°·82 | 44°·5 | 48°·6 | 57°·4 | 58°·62 | 64°· | 63°·5 | 58°·8 | 52°·6 | 47°·7 | 40°·4 | 51°·5 |
| Monthly range of ditto . | 26°·9 | 29°·7 | 27°·9 | 32°·4 | 33°· | 30°·2 | 29°·2 | 29°·3 | 27°·4 | 27°· | 31°·1 | 26°·3 | 29°·2 |
| Amt. of rain in inches . | 2·76 | 2·72 | 2·98 | 2·9 | 1·92 | 2·35 | 2·15 | 1·38 | 1·21 | 5·5 | 2·84 | 2·9 | 2·63 |
| Humidity of air . . . | ·866 | ·894 | ·839 | ·778 | ·798 | ·775 | ·785 | ·765 | ·748 | ·867 | ·912 | ·887 | ·825 |
| Barometer (reduced to 32°) | 29·47 | 29·74 | 29·61 | 29·69 | 29·58 | 29·855 | 29·935 | 29·905 | 29·906 | 29·805 | 29·88 | 29·69 | 29·755 |

TABLE No. 2.—Counties of England south of 55° Latitude.

| | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Mean of the Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature . | 34°·6 | 39°·5 | 42°·4 | 46°·3 | 57°·43 | 58°·8 | 65°·79 | 62°·83 | 56°·38 | 51°·75 | 45°·3 | 38°·1 | 49°·92 |
| Monthly range of ditto . | 30°·1 | 31°·4 | 38°· | 42°·3 | 47°·6 | 38°·5 | 37°·1 | 38°·3 | 36°·3 | 35°·5 | 32°·8 | 27°·2 | 37°·92 |
| Amt. of rain in inches . | 2· | 2·45 | 2·4 | 2·3 | 1·35 | 4·7 | 1·4 | 2·31 | 1·71 | 3·8 | 1·7 | 2·2 | 2·36 |
| Humidity of air . . . | ·905 | ·858 | ·848 | ·789 | ·734 | ·760 | ·750 | ·777 | ·783 | ·860 | ·888 | ·887 | ·820 |
| Barometer (reduced to 32°) | 29·701 | 29·835 | 29·861 | 29·658 | 29·763 | 29·89 | 29·954 | 29·98 | 29·843 | 29·782 | 29·817 | 29·642 | 29·81 |

Table No. 1 is the mean of the observations taken at Exeter by Thomas Shapter, Esq., M.D., and near Torquay by E. Vivian, Esq., affording explicit and accurate information on the climate of South Devon. The second Table gives a fair average for all the counties of England* south of 53° latitude. The mean degree of temperature in Devon is about 1°·5 above that of the southern and midland counties of England: a fact which might be anticipated from their relative degrees of latitude. A more minute examination of the monthly reports reveals to us the interesting fact, that during the summer months this county is absolutely colder than the whole range of country from the south coast to the 53° of latitude. The monthly range of temperature throughout the year is in favour of Devon, being on the average 7°·7 less than that stated in Table No. 2; and the *daily* range of heat maintains a similar steady character. The influence exerted on vegetation by the small variation of heat is very beneficial, and the gradual manner in which it occurs accelerates the growth of plants by *a more continuous development* of their organs. The annual quantity of rain and the humidity of the air are both largest in Table 1, and by comparison it will be observed that in the months of May, June, and July the atmosphere is moister; whilst during the greater part of the remaining months of the year it is drier. In the summer months, when the sun is pouring forth his scorching rays on vegetation, plants derive much refreshment and vigour from the gentle dews which nature supplies. At this time, therefore, they need an abundance of moisture in the air; and it is remarkable that this is the very period when Devonshire is favoured above other counties. The quantity of water thus deposited is regulated by the amount of vapour in the atmosphere, and the very profuse dews of this district are referable to this cause. This county is therefore well adapted for the cultivation of roots and other green crops where the soil suits: for corn more precarious. The above peculiarities

* I have taken for my guidance the meteorological observations published by the authority of the registrar-general, which are deservedly considered the most accurate that have been reported, the instruments having been compared with those of the Royal Society at Somerset House, and the observations taken with much care by gentlemen in different parts of the country; still a continuation of these observations for several years is desirable to correct or confirm these averages. The second table has been calculated from the reports of the following places:—Brighton, Chichester, Uckfield (Sussex), Beckington (Somerset), Royal Observatory and Maidenstone Hill, Greenwich, Lewisham (Kent), Walworth (Surrey), Latimer Rectory (Bucks), Aylesbury (Bucks), Hartwell (Bucks), Stone Observatory, Saffron Walden (Essex), Hereford, Cardington (Bedford), Thwaite (Suffolk), Cambridge, Norwich, Derby and Highfield House (Notts), Cornwall being purposely omitted as possessing many of the same peculiarities of climate as Devonshire.

of climate are referable to the situation of the county, which being bounded to a large extent by the sea is influenced by the same agency which modifies the climate of small islands. In the north of Devon the climate is colder than in the southern and less elevated districts: still it partakes of many of the modifications observed in south Devon. Local circumstances render the climate of some parts very peculiar: an instance of this kind is observed in the neighbourhood of Dartmoor, the temperature being much lower than on land of the same latitude and altitude. This extensive tract of land is situated on a mass of granite, which being impervious to water compels all that falls on it to pass away on its surface. In many parts it is a perfect swamp, and in general the surface is thoroughly saturated with moisture; the evaporation of which occasions the low temperature observed. The hilly surface of the county produces great variety of altitude and aspect, affecting the local climate and the nutritive value of vegetation in a remarkable degree, and the fertility of many estates is very much influenced by the circumstance.

### *Soils.*

The soils most prevalent in Devonshire appear to have been formed in the positions they now occupy, and few alluvial deposits are met with. Hence the varieties of soils are very evident, although few in number; and having been formed principally from the stratum on which they rest, a knowledge of the surface geology will convey a pretty correct idea of these varieties and their respective areas. It is needless for me here to enter into any further remarks on the geology of this county, as it has been recently treated of in a number* of this Society's Journal. I will therefore proceed to the variations in the nature and fertility of the soils which occur in this county.

Between Exeter and Crediton the soil is a rich sandy loam, and an extensive tract of similar character branches off in the direction of Hatherleigh. Turning from thence eastward, in the parish of Sandford, we find land of remarkable fertility, which, like those before-mentioned, partakes much of the character of the red sandstone rock on which it rests. This is considered to be the richest land in Devonshire, and I have no doubt of its really meriting the distinction. The district situated on this geological formation is the best farmed portion of the county, and the management of the land is far superior to the general practice of other parts. Nature has done much, but the agriculturist has not been idle; and it is much to be desired that similar intelligence and skill should be more commonly diffused throughout

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* Vol. iii., p. 21.

this highly-favoured county. Proceeding towards Collumpton, we enter the luxuriant vale of the Exe, which occupies an area of about 200 square miles, and extends by a north-western course to Tiverton, and south-west by Exeter to Topsham. The principal part is in pasture-land and supports a large number of dairy cows, but where it is converted into arable land it yields abundant crops. From Tiverton to the borders of Somerset the land is more clayey (argillaceous) and tenacious, it is also less fertile. Near this part are the Black Down hills, which are covered with a barren sand or gravel, occasionally improved by the intermixture of a calcareous soil.

The Vale of Honiton and Exeter constitutes our principal dairy district. The soil is a rich loam, of a dark hazel colour and considerable depth ; the subsoil is gravelly from Exeter to Bishop's-Clist, beyond which it is chiefly a strong clay. Much is in permanent pasture, and, from its productive character, this vale with that of the Exe may be considered as two of the richest in the kingdom. Towards the borders of Dorset, in the neighbourhood of Lyme Regis, the soil is of less fertility, being the blue lias clay. It is principally kept in pasturage, and probably cannot be more profitably employed in its *present* condition. Draining is very necessary, and great advantage would be derived from practising it even whilst in grass, as an increased quantity of *more nourishing* herbage would be obtained. Before we reach Sidmouth we re-enter the red sandstone district, from which town to Topsham the same soil is observed with much constancy. A deep red loam is its prevailing character, which very rarely requires draining, there being naturally a free passage for the water into the absorbent rock beneath. The crops are always very forward where this soil is found, and their early maturity is due to the dryness and consequent warmth of the land. It is however liable to be scorched up in the summer months, but the moisture of the atmosphere and the heavy dews which fall here materially diminish the injury which would otherwise arise.

The barren waste known as Woodbury Common is found in this portion of the county; its soil is a very poor sand, with a mixture of peaty matter. It produces a short grass, which is fed off during the summer by a few cattle, but the pasturage is of little value. Near Exminster is a rich loam, and the same extends towards Kenn ; Kenton and Mamhead occasionally becoming rather gravelly, which proportionately decreases its value. In the neighbourhood of Newton Bushell a calcareous soil abounds ; this town is situated in that portion of the county called the South Hams, a district of triangular shape, included within a boundary passing from Plymouth through Chudleigh to Torbay, thence by the sea-coast to the former town. It

contains 160,000 acres of land, very much intermixed and continually appearing in various stages from a heavy clay to a light calcareous soil; with such frequency do these changes occur that any account of its particular parts would rather confuse than edify the reader. If its extent and fertility be *collectively* considered this part certainly surpasses all in the county. This district, with the land between it and the county of Cornwall, is principally devoted to the breeding and rearing of cattle, consequently we find all the farm operations conducted so as to further this special object. I must notice the improved character of the farming near Tavistock. I consider that in no other part of the county have equally *rapid* advances been made, and if continued it will soon be an example for the county to follow. In the neighbourhood of the copper-mines much land remains in an uncultivated state which arises from an absolute poverty of soil rather than from injuries resulting from working these minerals.

Proceeding northwards we pass over an extensive district of land, of very inferior character. It occupies the whole extent of the carboniferous deposits, and its distinguishing soil is a poor yellow (occasionally white) clay, on a subsoil of clay or shillet (shale). The whole requires drainage, and until this is effected little hope can be entertained of its being better cultivated. It is now the most sterile, dreary, and worst cultivated tract of land in Devonshire; its extent is very considerable, occupying nearly *one half* of the county. In the *immediate* neighbourhood of Bideford and Torrington, also from the latter place to South Molton, the land is of better quality, and under more correct management. The soil is a clayey loam, and when well drained fairly remunerates the cultivator. Occasionally we meet with other pieces of land of better quality: these are generally very limited in extent, and the variation is attributable to local circumstances. In such cases we generally find in the soil a *mixture* of the decomposed portion of a neighbouring rock or of the adjacent geological formation with the soil; which, by supplying the clay with bodies in which it was previously deficient, affords to the plants growing on it a superior nourishment.

It is very interesting to observe how distinctly the boundaries of this district and those of the red sandstone soils are defined. The road from Exeter to Crediton shows it very plainly for several miles, and it is also quite evident in passing through Hatherleigh towards Bideford. It is at the former of these towns that these formations meet, and the traveller is astonished at the change here observed; for, after passing through the very fertile and well-wooded country from Crediton to Hatherleigh, he suddenly enters on a dreary and barren expanse of land of the nature before described. On the north of this barren district

the soil very much improves in its general character. Near Barnstaple the land is of great fertility, affording luxuriant pasturage, and towards Coombe Martin lessens in fertility but preserves the same undulating surface. From Coombe Martin to South Molton the land is poor and hilly, but a striking change is observed within a few miles of Tiverton; the northern portion of the county is principally in pasture, which produces abundant crops of grass and supports a large number of the North Devon cattle. The rearing of these is the principal employment of the farmers of this part, and, as I observed in the South Hams, so here also the general cultivation of the land is made subservient to it. Great attention has been paid to breeding for many years, and the success which has attended their attempts is evident in the high character maintained by the cattle of this district. It must not be considered that the North Devons are reared only on land of this quality, being found in great purity in the barren district on the carboniferous deposits. It is surprising how well they thrive on this poor herbage, preserving their condition and their *peculiar delicacy of touch* to a degree which surpasses all other breeds of cattle.

### *Tillage.*

The rotation of crops adopted in this country is known as "the old Devon course," or turnips, wheat, barley, oats, seeds two to six or more years. In more particularly noticing this system I shall enter into some details connected with the ordinary farm practice of the county.

*Preparation for Root Crops—Turnips and Swedes.*—The land is ploughed before winter, and having been exposed to the action of the air for some months is well worked as early in the following spring as the weather will permit. Lime and dung are the principal manures here employed, and advantage is taken of frosty weather for drawing these on the land. The lime is either mixed with earth and used as a compost, or is simply covered with a portion to defend it from the rain, as it is generally considered that when slaked by water it is inferior to that similarly acted on by the air. The quantity used varies with the distance for carriage; but in general, after the land has been well prepared, from 6 to 8 hogsheads are applied to the acre and immediately harrowed in. The farm-yard dung, when carted on the land, is placed in heaps in convenient parts of the field, generally as high as possible, so that in the busy season the draught may be down-hill. This is not sufficiently protected from the influence of the rain and air: for being thrown together lightly and remaining uncovered it rapidly ferments, when its volatile portions escape into the surrounding atmosphere, and much of its soluble

matter is washed away. The quantity applied per acre averages from 10 to 12 two-horse cartloads, which is spread after the lime and ploughed into the land. I would here recommend greater expedition in covering in the manure, as it is seriously injured by the exposure which it now so freely receives. In the South Hams the land is *skirted* (ploughed so as to miss a portion), harrowed, and burnt; the ashes are removed and afterwards drilled with the seed, being looked upon as a sufficient manure for the root-crop. The land is now ploughed 6 inches deep: a small quantity of dung is then spread, after which it receives another ploughing.

The turnip is drilled on the flat at distances varying from 12 to 18 inches, and the swede from 18 to 27 inches. The latter is not commonly cultivated in Devonshire; but, where it has been tried, an increased quantity of land is annually devoted to its growth. The varieties preferred are Skirving's purple top and the copper-crowns; the favourite turnips are the white globe and green round. The use of some artificial manure (such as guano and superphosphate of lime) is frequently adopted, as by its stimulating properties the young plant is rapidly pushed into the rough leaf, and is thus secured from the turnip-fly. Hoeing is practised, but not to the extent which its advantages would justify. On some farms, where the horse and hand hoes are well used, the crops equal the best-farmed districts of England; but these instances are so rare, that I am induced to add a few reasons for the practice. Whatever crop we intend to cultivate, *to that plant alone* should the soil yield its nourishment and support, and all others must be looked upon as intruders which plunder that which belongs solely to the former. The land cannot yield two crops without a diminution in the quantity of each; and, if weeds are tolerated, more useful plants are proportionately checked in their growth. The present crop suffers from this cause, the succeeding corn-crops are very foul, and when the land is laid down in grass it is totally unfit for the reception of seed. The singling of the plants, their proper distance in the rows, and the general cleanness of the crop are absolute essentials for a large produce, and few who have not noticed it would credit the difference caused by this more perfect tillage. Attention to these points will well reward any farmer for the extra supervision necessary. It is from this neglect that the produce of this district is so far below what the fertility of the land and a genial climate would lead us to expect—15 tons per acre being the average for the county, not one-half what it might be under the system recommended. All the turnips and one-third of the swedes are fed on the ground by sheep, and the remainder are drawn either to the homestead for cattle or to the pasture-land for ewes. Artificial

food is seldom consumed with these roots, either on the land or in the fatting shed. The value of these agents is very imperfectly estimated, for with a judicious selection it is the cheapest mode of enriching a farm.

*The potato,* until the last three years, was after the turnip the most important of our root-crops. Its cultivation as a field-crop was practised in Devonshire as soon as in (*if not prior to*) any other part of England or Scotland; and for this early introduction we are indebted to Sir Walter Raleigh. The soil of a large portion of the county is well adapted for its growth, but the land near Moreton Hampstead has been celebrated for many years for the quality of the roots grown there. The soil is decomposed granite, which is peculiarly suited to this root, being free in its nature, and containing a large supply of the alkali potash, which is so necessary for the healthy development of this plant. This land was reclaimed from the moor in or about the year 1700, but previously it existed in a condition similar to that by which it is now surrounded. The potato was from the first extensively cultivated there, and the management was very much the same as that now adopted. Chapple thus describes its tillage: "None have more industriously applied themselves to the cultivation of this valuable root than the inhabitants of Moreton Hampstead; who have converted their furzy downs into good pasture and tillage land, affording a sufficient manure of lime and dung, and then tilling it with potatoes, which, besides ameliorating the ground and fitting it for corn, yield of themselves a profitable return. After which they have two, or sometimes three, corn-crops without any further manure, and they lay it down for some time as pasture." The present disease in the potato, having occasioned severe losses to many farmers in this county, will lessen (for a time) its culture; but I anticipate that, as the cause is probably atmospheric agency, and not any diminished vigour in the plant, we shall ere long obtain them in the same healthy condition as that in which they existed prior to this disease.

*Mangold wurzel.*—This root is not extensively cultivated in Devonshire, although the large produce obtained in some parts proves that it is worthy of greater attention. In the neighbourhood of Tavistock it is cultivated with great spirit and success; but in the West it is seldom attempted, partly from the poverty of the soil, and also from the land not being prepared for the early sowing this plant requires. The latter results from postponing the autumn culture until the busy season of spring.

*The carrot* has not received the attention of the agriculturists of this part to the extent it deserves. Its high value as a food, coupled with the fact that it does not materially impoverish the surface soil, are strong points in its favour, and demand our con-

sideration in determining the relative value of fallow-crops. The importance of this point will be more evident on comparing this root with the potato; the latter is one of the grossest feeders cultivated, and draws from the soil almost all the fertilizing qualities of the manure used, and leaves the land very slightly improved. The carrot, by penetrating more deeply into the soil, obtains food which would not be available to other plants, and leaves the land in a better state for the succeeding corn-crop. As it requires a deeply-cultivated soil of a porous character for its successful cultivation, the red-sandstone soils are peculiarly suited for it; but, being an uncertain crop, *unless carefully cultivated,* is probably the cause of the limited extent of land devoted to it.

*Rape.*—The value of this plant as a preparation for wheat is becoming well known in this part, although at present comparatively few farmers raise it, yet their number is rapidly increasing. Its high feeding qualities render it an excellent food for sheep.

There is at present great difficulty in preparing the clay-land in the west of the county for root-crops, and the course of husbandry now pursued is in many particulars very defective. I recommend that *immediately after harvest* the wheat-stubble should be ploughed and well cleaned; it should then be thrown into ridges about 30 inches apart, and remain in that state until the following spring. The beneficial effect of this exposure to the sun, air, and frost will be evident on these clay-soils; and when the land is cross-ploughed in the spring, it will be found more friable and in much better condition than under the ordinary practice. In soils of this deseription (poor yellow clay) there is a peculiar sourness which is very prejudicial to vegetation, and not only will this be entirely destroyed, but, by the disintegration of the soil itself, much matter will be made available to vegetation which was previously existing in a form that plants could not assimilate.

The land which is intended for the growth of mangold wurzel especially requires this preparation. After it has been cleaned and thrown into ridges (30 inches apart), the manure should be spread between them, when they are to be immediately split by a double-mouldboard plough, and remains in this state until the proper season for sowing the seed arrives. This method can only be adopted with advantage on clay soils, for in porous soils the passage of water would of necessity impoverish the manure. By this mode a fine seed-bed is provided—the delay, which would arise from a wet spring, is avoided; and, moreover, the operations are completed more perfectly, and at less expense, than if postponed to the following spring: indeed, the general

cultivation of these soils will be more effectual during the autumn than in any other season. I would also recommend the autumn cultivation for the lighter land district, as thereby a crop of spring feed might be more frequently obtained before the root-crops than is the practice at the present time.

*Preparation for Corn-crops,—Wheat.*—As the land is cleared of the roots it is ploughed up, and wheat sown when the weather and other circumstances will allow. It is in general sown broadcast, for the land being hilly is a great hinderance to the use of the drill. The crop receives little further attention until the period of harvest arrives. It is commonly bagged, which is (with the exception of mowing) the best mode of obtaining a short stubble. The practice of collecting corn into a number of small stacks to dry and harden before it is finally housed, or, as it is provincially termed, "airish mow," has been generally abandoned. The best method of making "the mow" is to place the sheaves with their ears inwards, and, as every fresh layer is added, to diminish the circle until it forms a conical heap, containing from 1 to 1½ loads of corn. A small quantity of straw or reed is required for capping, and it is then perfectly secure from the weather. It is useful in wet harvests, for the crop may thus be preserved from the rain as soon as it is moderately dry, whereas it would materially injure the sample to put it into an ordinary stack. This practice was no doubt originally adopted on account of this county being particularly subject to rain during wet seasons.

The quality of the wheat grown in the neighbourhood of Exeter is very good, and always commands a full price in the market. The average produce is estimated at 24 bushels per acre. A large proportion of the wheat-straw is made into reed for thatching; and I will describe the process for making it, on account of its superiority over straw. The sheaf of wheat is held so that the ears alone are exposed to the action of the threshing machine; it is then withdrawn, and, having been turned, is again replaced in the same manner. The greater part of the corn is thus removed from the straw without its original firmness being destroyed; and by the use of the flail it is cleaned from any corn which escaped the machine. This being effected a small quantity of straw (an ordinary sheaf) is separated and tied just below the ears by means of a rope, one end of which is fastened to the barn-wall, whilst the other is held in the hand. It is now combed by an instrument supplied with four or five teeth, which are bent inwards, and any *loose straw* is thus separated. The labourer thus proceeds until he has prepared a bundle (28 lbs.); this is now examined, any ears which had escaped previous observation are picked out; it is then bound securely, and the manufacture is completed by trimming it with a sickle.

The straw which has been separated during this process is reserved and passed through the threshing machine. A man can make 11 bundles in a day, and when used for thatch less manual labour is required than with straw; it is also much neater in appearance, and more durable. The usual price for thatching is 2*s.* per square (100 feet), and for a rick of 10 acres of good corn about 3*s.*, with the usual allowance (2 quarts daily) of cider. In addition to the above, the thatcher is suppled with materials for making spars, but this labour is included in the above cost.

If the land *is in good condition* barley succeeds wheat, and is *followed by oats;* if not, only one additional corn-crop is taken, and the land is laid down in grass. The first crop is cut for hay, and it is then fed off by cattle or sheep until the land is supposed to have regained its exhausted strength. Such, then, is the "old Devon course"—a rotation which can scarcely show one good qualification, but combines all that we should most strenuously avoid. It cannot be too severely condemned, as a *good* rotation of crops is the foundation of farm economy. The reader must not suppose that this system exists without many exceptions, especially in the neighbourhood of large towns, and throughout the principal part of the red sandstone district where improvements have been introduced. In these cases the four or five course is pursued according to the quality of the land, viz., turnips, barley or oats, clover or grass (one or two years) and wheat. The value of this system is too well known to require any comment, and I strongly urge its adoption in the place of the old Devon course as the latter is a complete check to agricultural improvement.

### *Manures.*

*Farm-yard Manure.*—Little attention is devoted to the proper management of this most valuable fertiliser. It is frequently heaped in the most exposed situations, where its ammoniacal compounds are drawn off by the heat of the sun, and its alkalies and phosphates are wasted away by the rain falling on it. The important relation which a good supply of rich manure bears to remunerative farming induces me to notice its management more minutely. The best mode of collecting this manure is that termed the box or pit system. I consider it preferable to stalls, from the large quantity of straw converted into manure—the more perfect preservation of its fertilising agents as well as the ease with which we may control its fermentation. The liquid manure which now drains away unchecked in its course is here retained *in the manure* until it is required to yield its fertilising matter to the land. Its application is far more efficacious when incorporated with the solid portions of the manure than when

used in its liquid state. When it is collected in a tank it should be pumped on the manure heaps instead of being distributed by an ordinary cart. It too frequently happens that no means are adopted for its preservation, and it is permitted to drain away as if it were quite worthless and unworthy of our care. The remedy for this evil is practicable in the majority of cases, and the difficulty does not so much exist in its application to the circumstances of the several instances as in convincing the farmer of the loss he really suffers by so much waste. By chemical analysis this liquid is found to contain the richest portions of our manure (the alkaline salts and the phosphates), and that which is chiefly required by the growing plant. The demands which plants make on the soil (and which we employ manure to supply) are principally the *mineral ingredients found with such constancy in their ashes,* and these can only be taken up when dissolved in water. It will therefore be evident to all that, by allowing this liquid to waste, we are losing that portion of our manure which is most adapted for the support of vegetable life. It is with difficulty that the fertility of land can be maintained which is constantly impoverished by the corn and stock removed to market, and hence the greater need to supply, by means of *well*-prepared manure, the demands thus year by year made on the soil. But whilst I strenuously maintain that *the mineral matter* of plants performs most important functions in their economy, I consider that an abundant supply of their *organic constituents* is equally essential for obtaining a *vigorous and healthy development* of their organs. I shall therefore describe the mode of regulating the fermentation of this manure and the best state in which it can be applied. The character of the land determines the mode of procedure. For a clay soil I should compress it as much as possible, and preserve it in large heaps. In forming the heap the cart should be drawn over it and unloaded when on the top, where the dung is to be spread by a labourer. The ends are afterwards cut back, and the heap being thus brought into a proper form is well covered with the cleanings of ditches, good mould or *burnt clay.* These bodies from their absorbent character retain much of the ammonia given off from the heap which would otherwise be lost. The manure should remain in this state until it is required to be spread, and it must then be ploughed into the land with *as little delay* as possible. I thus apply my manure before it has fermented to any extent, in order that the heat given off during its decay may be absorbed in the soil, thus lessening in a great degree that check to vegetation which is occasioned by the coldness of clay lands.

In preparing manure for a sandy or loamy soil my method would differ in some respects. *The lighter and more porous the*

*soil the more rotten should the dung be* when applied to the land. In order to check the fermentation in the previous instance, I directed the carts to be drawn over the heap of manure, and thus I obtain the desired result *by the exclusion of the air.* In this case we require the fermentation to proceed rapidly, and to effect this object the heaps should be thrown together, and turned twice or thrice according to the character of the land for which it is intended and must be properly covered with mould or some other body after each turning. From the previous statements it will be seen that the present practice of this part renders the *quality* of the manure inferior to that obtained under more correct management, and I must now recommend *an increase of quantity.* This will be most economically obtained by consuming a larger amount of the farm produce with artificial food for fatting cattle and sheep. The expenses of the latter will be well repaid if judgment is shown in its selection and use—we may thus obtain an abundant supply of rich manure at a very trifling expense. This source of manure is far more worthy the attention of agriculturists than some artificial manures which are now in such general demand.

*Lime.*—This county is well supplied with this manure, and it is very extensively employed. It appears to have been first used for this purpose rather more than two centuries ago, for Risdon, in his report on this county, written in 1640, states the practice to have recently commenced. It is a valuable manure, but in many cases is most injudiciously applied. There is no manure in common use more injurious when applied without judgment; but, when carefully used, few can be found more valuable to the agriculturist or more efficient to assist him in his operations. In Devonshire its abundance leads many to employ it, irrespective of the character of the soil. I have previously stated that it is generally applied immediately before the manure for the turnip-crop. I would here suggest the propriety of its application to the clover ley before ploughing for wheat if the four or five course is followed, or to the wheat-stubble where the "old Devon course" is adopted. I cannot enter into a consideration of the principles which should regulate our employment of this manure, from the length to which the details would necessarily carry me; but as the subject will no doubt be noticed in the Prize Essay for the use of lime as a manure, to that I must refer the reader for further information.

In the neighbourhood of Woodbury, as well as in many other parts, lime is mixed with farm-yard dung, and allowed to remain in this state several days before it is spread. It is well known that lime mixed with any animal manures (after the process of fermentation has commenced) will liberate the ammonia they con-

tain, and thereby seriously diminish their value. I feel assured that this practice only requires to be noticed for its inconsistency to be admitted.

In the South Hams the use of lime, together with paring and burning, are the principal means upon which they rely for maintaining the fertility of their arable land. The latter practice is supposed to have originated in this county; hence its name Denshiring (abbreviation of Devonshiring). In the commencement of the seventeenth century it constituted a regular portion of the tillage operations; but shortly after this the use of lime as a manure *superseded it,* and from that time it has been gradually becoming a less general practice. The effects of each are in some respects similar—both act as stimulants to the land, and render it more productive by changing the dormant constituents of the soil into a condition available for the support of vegetable life. It is therefore evident that by their continued use we must ultimately impoverish the soil. This evil is seriously increased in the south of Devon by their applying only a *small portion* of the farm-yard manure to the arable land. Thus they continue to stimulate the soil to yield its nourishment to their crops, which are either disposed of in the market as corn and cattle, or laid on their *pasture* land as manure.

*Sea-sand.*—In the north and west of Devonshire the application of sea-sand to the land is considered equal to lime as a stimulating manure, but it also possesses fertilising properties of which the latter is destitute. It is found on several parts of the coast of Cornwall; but this county is supplied from the neighbourhood of Bude, where it forms a large bank on the sea-shore of considerable length; and although many thousand tons are removed every month no decrease is observable, the loss being supplied on the return of the following tide. This commodity forms the principal article of traffic on the Bude and Launceston Canal by means of which it is conveyed at a trifling expense, and depôts are established on its banks for supplying the district through which it passes. Considerable quantities are also freighted to London for the manufacture of certain patent manures. By a microscopic examination it appears to consist of the fragments of common coast-shells, amongst which are oysters, scallops, cockles, and muscles, with the spines of sea urchins. These live between low tide and 30 fathom water, and are therefore readily brought under the influence of the breakers.

On arable it is generally applied at the rate of 80 or 90 seams (11 or 13 two-horse cart-loads) per acre before ploughing for wheat. It is a valuable manure for grass land, and produces a sweet and luxuriant herbage.

*Sea-weed* is another natural manure which our maritime posi-

tion supplies in abundance. The best mode of application is in the form of a compost. For this purpose during the winter months the weed is drawn from the shore and formed into heaps, and lime is laid between every layer of 6 or 8 inches in depth. After remaining in this state for two or three months it is turned occasionally, and, when well decayed, is applied to the land before a root-crop, generally potatoes. In clay soils its beneficial effects are evident, for, in addition to its fertilising properties, it renders the land less tenacious; and the roots obtaining their supplies of food more readily, the crop grows with increased luxuriance. When employed on sandy land it maintains a degree of moisture in the soil during the summer months, arising from the attraction of water by the salt.

## *Draining.*

The value and importance of drainage is well known, and within a few years extraordinary advances have been made towards its more perfect practice throughout this county. Reference to a geological map will show the districts in which draining is necessary. The *whole area* occupied by the carboniferous deposits having a retentive clay soil on a similar subsoil stands much in need of artificial drainage. The hilly land of this district contains a large number of springs, and we find many of the drains taking a serpentine course, so as to tap as many springs as possible; but the better plan is to cut branches from parallel drains. In the South Hams the soils are intermingled, some permitting the surface water to percolate through them freely, whilst others are closer in their texture and retain it. Hence throughout this district draining is only *partially* necessary. Passing to the soils on the red sandstone formation, we find them for the most part possessing a natural drainage into the porous substratum of sand, and, except in a few instances where clayey loams occur, no artificial drainage is necessary. The general practice of this county has been stone-draining, and occasionally horseshoe tiles and soles. Within two or three years more improved methods have been adopted on the estates of Earl Fortescue in North Devon, and through the agency of the West of England and South Wales Land Drainage Company on much land in this and neighbouring counties. This company was established "to afford to landowners and occupiers increased facilities for the draining of their lands, by executing the necessary operations with the most suitable materials in such a manner as may be deemed the most scientific, economical, and effectual; or by the advance of capital for such purposes, the cost incurred thereby, or the money advanced to be repaid by instalments." It is pleasing to observe that the success which has attended the ope-

rations of this *valuable* company has exceeded the most sanguine anticipations of its supporters, having given perfect satisfaction to the proprietors and tenants of the land drained, and also well remunerated the shareholders. I feel it would be superfluous for me to advance any arguments in support of a practice so generally appreciated. Want of capital is the principal impediment to its progress; but, notwithstanding this, its advances are great and annually increasing.

### *Implements.*

The agricultural implements of any part afford a good criterion by which to decide the *extent and character* of the improvements which may have been introduced into the farming there practised. Within the last five years the general character of their implements has much improved, and many of the awkward and cumbrous tools then in use are now superseded by others of more convenient form and practical utility. The only implement which I shall describe is Lowcock's double-plough. It is employed in ploughing steep land, and is very convenient for this purpose. It is supplied with two mould-boards, placed "back to back;" the body of the plough is never turned, but the handle is simply raised and turned over: at the same time the horses are brought to the opposite end of the plough. The ring, which previously connected them with the plough, slides up an iron rod at the side, and becomes again attached to another bridle of the plough. In order to reduce friction only one point of the plough is kept in the soil, being thrown into or out of work according to the direction of the handles.

Threshing-machines are frequently found on large farms, and are usually driven by horse-labour. In a few cases we find water-power used; and I am surprised it should be so rarely employed, considering the opportunities which exist throughout this county. The drill is becoming more extensively used for the turnip and swede crops, but is rarely employed for any other seed. Improved implements are gradually coming into use in this county, and the increasing number of spirited agriculturists, who introduce the improvements of other parts, and stimulate native talent and mechanical skill, materially extend their employment.

### *Orchards.*

A large extent of land in this county is occupied in the growth of apples, for the manufacture of cider. The apple was cultivated here as early as 1520 (Hoker's MS. Survey), but in the beginning of the following century received more attention, extensive tracts being devoted to its growth, "for furnishing their own

table and the neighbouring markets, but more especially for making cider" (Westcote).

The varieties of the apple preferred for cider cannot be enumerated. Unlike those raised for table-fruit (which may be distinguished by their particular names throughout the country) the nurserymen give names to these varieties which have merely a *local* value, being probably unknown at the distance of a few miles.

Great care is shown in the early culture of the apple. The pips are sown in February, in a rich loamy soil, which has been well prepared for their reception. In the following November the plants are taken up, sorted, all side-shoots trimmed off close to the stock, and roots shortened. They are now bedded in ground which has been double trenched, and well manured, in rows 2 feet apart, and 6 inches between the plants. The next November they are treated as on the previous year, and planted in ground similarly prepared, in rows, 4 feet by 2 feet. In the succeeding March or April they are grafted, and the next spring the nursery cultivation is completed by "heading them back," to make a 5 feet stem. It is very important to keep the land clean of weeds during all the stages of the plants' growth. Some persons prefer grafting on the crab-stock, as more hardy, rooting more freely, and making the largest trees. At 6 years old the young trees are planted on the orchard land at 25 or 30 feet apart. In the third season after planting they will commence bearing fruit; and when they arrive at 16 or 20 years of age are generally in full bearing. After they are 40 or 50 years of age few apple-trees are worth standing, although instances are on record of orchards producing abundantly when 200 years old. The orchard of Buckland Priory, which was one of the first planted in Devonshire, was in full bearing, and well stocked at this age (Marshall).

The variety of the apple and soil affect the time at which the tree arrives at maturity, as well as the period when its produce diminishes. The subsoil appears to exert a more powerful influence on the tree than the surface-soil, because its roots spread in the former, and thence derive their nourishment. It is an interesting fact that those districts which are *celebrated* for their cider are situated on *the cornstone and marls* of the old red sandstone formation: nor must this statement be limited to this county, for it is still more evident in certain parts of Worcester, Hereford, and Somersetshires. The presence of lime appears to be *essentially necessary* for the successful culture of the apple, and *a dry sub-soil* is of *equal* importance; both of which qualifications are possessed by the soils I have mentioned. A sheltered position and a south-east aspect is very advantageous for an orchard,

as the blossom will set better, and the fruit be more perfectly ripened. The produce of fruit varies much with the season, yet the alternate crops are generally superior to the intermediate ones, as if the tree, having exhausted itself by the production of a heavy prop, required a period of rest to recruit its strength and vigour. Ten hogsheads of cider per acre may be taken as an average produce for this county, although it is nearly double in some seasons.

That the present mode of manufacturing cider is very imperfect and uncertain few will be disposed to deny, and the cause may be traced to the fact that the change they are anxious to effect is seldom fully understood. The apples having been gathered from the ground and trees, remain in heaps in the orchard for two or three weeks, when they are removed to the pound. The expressed juice* is collected in casks, where the fermentation commences. When this has sufficiently advanced it is racked into another cask, and if fermentation is observed again to commence it is racked a second time, and is similarly treated until this tendency to ferment is removed, frequently requiring it to be repeated a third and sometimes even a fourth time. Other means are occasionally employed when it becomes violent, such as the fumes of sulphur, or compounds of chalk, called anti-ferments. The former process imparts a peculiar flavour to the liquor, which is readily detected by persons accustomed to its use: it is technically termed "matching" the cider. Much of the sweet Devonshire cider sold in London and other places is thus treated, and afterwards rendered palatable by sugar and similar bodies. None of the plans in practice at present can be confidently relied on for stopping the fermentation: but the process of frequent racking is the one on which the majority depend. A brief consideration of the principles involved in the practice of cider making will enable us to discover the causes of failure, and may probably suggest the remedy.

The *indiscriminate mixture* of apples is a *very* defective part of the manufacture of cider, as the character of the juice is materially influenced by the ripeness of the fruit when crushed. To obtain cider of the best quality the apples must be so carefully assorted in the heaps that the whole may become mellow *at the same time*. Farmers can generally judge correctly on this point, and little difficulty will arise in accomplishing it. The *colour of the skin* requires attention, as a careless mixture is incom-

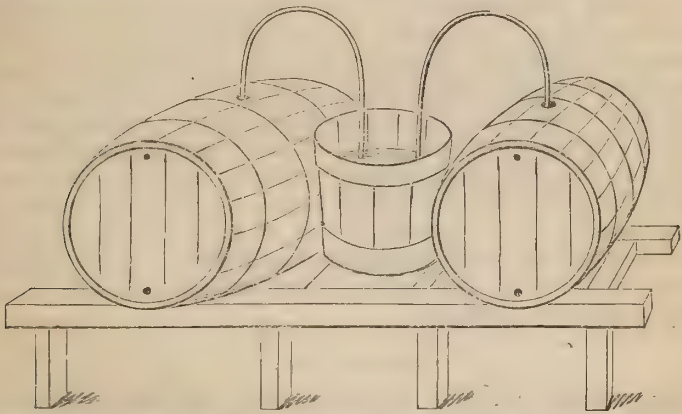
* In some parts *the pulp*, which remains in the press bags after the cider has been obtained, is replaced in the mill, and some water being added is again ground. The liquor afterwards separated is "water cider," and is a very pleasant drink, but will not keep long. The quantity of water added should be about one-tenth of the cider previously obtained.

patible with the manufacture of superior cider. *Yellow* and *white* apples quickly become mellow, and should only be allowed *to sweat,* whilst the red requires to remain longer in the heap; but this is still more important *with green skinned fruit.* The action of frost on the latter before they are crushed is essentially necessary, without which they cannot fail to yield a rough cider. For a similar reason "windfalls" and gathered fruit should not be mixed; for although the former will yield a cider fit for ordinary use, yet when pressed with fruit of better quality the produce is *very much* deteriorated. The advantage attending a judicious assortment of the fruit arises from the fermentation *of the whole* being simultaneous. Experience has determined that the juice of apples differs with the colour of the fruit from which it is obtained. If red apples of sufficient mellowness can be judiciously selected to be ground and pressed with others of lighter colour they will greatly improve the quality of the cider, by giving more "body," and rendering it less liable to become sour, which is peculiarly the case in the juice of the latter. The machines by which the apples are ground into a pulp, and the juice is separated, require improvement in order that their skins and *pips* may be *well bruised,* as the "body" and flavour of the cider is much improved thereby.

The juice of the apple, as it is collected from the press, possesses the means of producing and maintaining a fermentation by which the *sugar* it contains is changed into *spirit.* If this fermentation be not under control it soon changes its character, and converts the spirit already formed into *vinegar,* consequently the cider becomes sour. It is to the second stage that we have principally to direct our attention. This change of spirit into vinegar cannot take place at any temperature below 45° Fah., or in a liquor free from the albuminous matter, which acts as a ferment. Thus we have the power of entirely preventing the change which is productive of such large losses to our cider manufacturers. For this reason *cold weather* should be preferred for making or racking cider. The process of racking is an imperfect separation of the fermenting matter in cider. The sediment at the bottom of the cask is the only portion separated; but every careful observer must be aware that much is conveyed *in the liquid* which continues to fret the liquor; and this is *very apparent* in those cases in which *frequent* racking is resorted to. In pursuing the method I have recommended, not only is the sediment separated by racking, but by the use of wood charcoal the ferment is rendered harmless, and the subsequent introduction of some isinglass completely removes it. This body (isinglass) has the peculiar power of forming itself into a network, and as it gradually sinks in the vessel, so it carries with it all *solid* matter

which may be floating in the liquid. There is another part of this plan for making cider to which I would direct notice. In the manufacture of fermented liquors it is desirable to exclude the air after they have passed a certain stage; but *the safety of the cask* prevents this being done. A very simple method which I will now describe fully accomplishes both of these desiderata.* The water into which the tube dips acts as an elastic spring, which, whilst it causes no pressure on the liquid in the cask, is a *perfectly air-tight* valve. I am well aware that the produce of different orchards varies greatly, even where the same process is adopted; but I am convinced that these disparities may be lessened, and the quality much improved, if its manufacture were conducted in accordance with correct principles. We should

* The juice of *carefully assorted* fruit as it comes from the press is collected in casks, and placed in a *cool* situation for two or three days. To every 60 gallons add about 12 ounces of wood charcoal (coarsely crushed), and a few hours after 4 ounces of isinglass dissolved in some cider. The cask is now to be tightly bunged and a syphon-shaped tube (½ inch in diameter) firmly introduced into the cork in such a manner that the end thus fixed *does not reach the liquid in the cask.* The opposite end dips into a vessel of water supported at the side, as is represented in this drawing.



After a few days, when the liquid is considered clear, it should be *quickly* and *carefully* racked. It is now to be treated with another quantity of charcoal and isinglass as on the previous occasion, and the whole to be again secured by the tube as above directed. It may remain in its present state for a few weeks, and after another racking will afford a *delicious* beverage. If the cider is to be kept any length of time, it is a good plan to suspend from the bung one or two pounds of sugar-candy in a bag, for cider requires something on which to "feed," and if it is perfectly free from solid matter it destroys its own "body," but the presence of sugar prevents this. The racking should be done in *clear* weather, and as cold as possible.

reasonably anticipate as much variation in the produce of seasons and localities in this country as we find in the vineyards on the continent; and if the same care were taken in obtaining and perfecting cider as is there observed with regard to wines, doubtless the "growth" of particular years would be equally valued.

Orchards are generally kept in grass which is fed by sheep; they are rarely cultivated, but potatoes are occasionally grown in them. It is considered after a few years to injure the value of the cider, but this probably arises from the land becoming of better quality. The crop of apples is frequently injured by attacks from the caterpillars of two or three moths which are concealed in the blossom or leaves, and generally termed *the blight*. Little can be done to check their ravages, although some have tried *with success* the method of burning weeds or wet straw on the windward side of the orchard at the time the fly deposits her eggs. The apple also suffers much in some seasons from the woolly aphis (Aphis lanigera) and other small insects. Lime is the best remedy, being easily applied and very efficacious. Canker is a disease to which some orchards are subject, arising frequently from want of drainage; in other instances from causes not so easily detected. I have known cases in which, by *regrafting the head*, the tree has recovered.

Valuable as the orchard is to the Devonshire farmer (*and its worth may be very much increased*), it is remarkable that so little attention is bestowed upon it either in the selection of good varieties or in the manufacture of the cider. The value of cider varies from 2*l.* to 5*l.* per hogshead, but the greater quantity does not sell for more than 2*l.* 10*s.* The average produce has been stated at 10 hogsheads per acre; and we can thus form some idea of the pecuniary loss which [now] results from imperfect management. The manufacture of cider is a subject replete with matter for scientific investigation, and offers *great inducements* to those who, by an application of this information, can render the practice more perfect.

### *Grass-Land.*

Little worthy of notice is observable in the general management of grass-land in this county. An exception however occurs in the South Hams, for farmers are frequently *compelled by their leases* to apply *all* or *the greater part* of their farmyard-manure to the land which is in permanent pasture. When they do not impoverish their arable land to this extent it is very common for them to apply 100 to 150 seams (20 to 30 two-horse cartloads) of dung per acre.

This county being very much intersected by rivers we have an abundance of meadow-land. The land is generally of good

quality and produces large crops of hay and aftermath, but a slight inspection will show us that the quantity may be readily increased by the employment of resources which are *generally available.* I refer to the practice of irrigating meadow-land, and I find that notwithstanding the inducements which land thus treated offers to the farmer, yet comparatively speaking he has rarely benefited himself by its application. There are two modes of irrigating land, and the nature of the surface determines our course of procedure. When the land is hilly and a copious supply of water at our disposal, the *catchwork* principle is adopted. It is peculiarly applicable to the hill sides of this county, which have good springs of water at a favourable height. Great care is necessary in laying out land for irrigation in order to derive full advantage from the practice; but the expenses of carrying out this method are of small amount and quickly repaid. The cost varies with the difficulties of the locality, from 2*l.* per acre—the capital thus expended frequently pays from 40 to 50 per cent. annually. This is surely sufficient inducement to lead to a more attentive consideration of its merits, for much land which now produces little but heath and fern may be converted into good pasture-land. The ordinary mode of procedure is to pare and burn the surface, apply the ashes with a liberal quantity of lime, and then get a crop of turnips. These are fed on the land, and the grass-seed is then sown. The water passages are finally cut according to the surface of the land at distances varying from 20 to 30 yards regulated by the texture of the soil and the slope of the ground—the fall should be about 1 in 80 or 100. Attention in thoroughly cleaning the land is well repaid, and care should be exercised in selecting the varieties of seeds best adapted for water-meadows. The water after it has been used on the steep land may be advantageously employed on the flat bottoms, but this should not be done if a *fresh* supply can be obtained, for its value for irrigation decreases in proportion to the extent of surface over which it has passed.

I have omitted any descriptive account of the method adopted for watering flat meadows as it does not differ from the general practice of other counties. There is another point of management which demands more attention than is here devoted to it. It is essentially necessary for a good water-meadow that two rules should be complied with, viz., that the plant receives a *proper* supply of water; and in the second place, that this water must *never stagnate* in the soil. It is to the latter that I now refer, and I would, therefore, urge the importance of irrigated land being properly drained. It is water *in motion* which is beneficial to vegetation; but when it becomes *stationary* its action is reversed and

an unhealthy growth is immediately induced in the plant. The *quality* of the herbage is also injured by the more valuable varieties of grass being replaced by others of inferior character and less nutritious properties. The aquatic plants which are so frequent in our meadows plainly indicate the want of drainage, and few persons can form any conception of the check thus exerted on the productive powers of the soil. If the land is well laid out this will be easily effected by means of open drains, and especially if it be thrown into lands having a gentle declivity, with the water supplied at the crown of the ridge. Natural evidences of the advantage of draining are occasionally met with, as, for instance, where the land has a porous subsoil, which affords the water a free outlet, and consequently an increased herbage is produced.

If the agriculturists of Devon would *rightly estimate* the means at their disposal, and could be led to their better application by *regular and systematic* flooding, and the more perfect removal of the water, their private interests would be benefited and the public welfare promoted.

### *Cattle.*

The cattle which are preferred by the farmers of this county are the North Devon breed, and its crosses with the Guernsey or Somerset. On the north and west of Tiverton the North Devons prevail; but from that town to the neighbourhood of Newton Bushell this breed is not in general so pure. The characteristic peculiarities of the North Devon breed are so well known and valued throughout England as to render any description of them unnecessary. If the *general character* of the North Devons was compared with any other breed of cattle, more particularly in reference to their shape, aptitude for fattening, quickness and steadiness of draught, as also their value for dairy purposes taken collectively, they would be found best adapted to the requirements of the agriculturists of this county. Circumstances exist in other counties which modify the *comparative value* of this breed, the above statement must therefore be considered as bearing only on Devonshire. Numerous attempts have been made to improve North Devon cattle by an intermixture of other breeds. The Devon ox being rather below the ordinary size, a cross with the Hereford was expected to increase it, but this was effected with a proportionate decrease of their activity. For dairy purposes they are rarely preserved pure, it being considered that a *slight touch* of the Guernsey renders them more profitable. In the northern district of this county the rearing of cattle is the principal source of profit to the farmer. Agriculture here occupies a secondary position, and neither the dairy nor feeding for

the butcher forms a part of their general practice. The steers when they have attained the age of three years are sold as working oxen. The principal fairs for these are held at Crediton and South Molton, and the majority of those purchased by Devonshire farmers are driven to the north and east of Exeter. They are worked one or two seasons, after which they are fattened and the flesh is rendered more delicate by this period of *gentle* labour. The more general practice is to purchase them in the spring—work them until the middle of summer, and then graze them in preparation for the fatting-stall in October or November. The ordinary mode of working them is by means of the yoke, which is much preferred to harness. The yoke is constructed so as to proportion the relative draught of the animals to their strength. If an ox is weaker than his companion, the iron by which the draught-chain is attached to the yoke is placed at *a greater distance from the weaker*, thus giving it a mechanical advantage. Cattle are very rarely employed in carts on the roads, this being a practice almost obsolete.

A large district in the south of Devon, comprising the South Hams, and the land on its west, is devoted to the rearing of cattle. They are grazed until 3 years old, when they are fattened for the *neighbouring* markets and navy provisions. The breed of cattle found in this portion of our county is known as the South Hams variety, and are supposed to have originally sprung from the North Devons, but are now a distinct breed, differing in most points from the parent stock. Their flesh is inferior to the North Devon cattle; but they are much liked *in this part* for their good feeding qualities. The careless mode of breeding adopted at the present time removes all hope of any immediate improvement. A careful selection of breeding stock would improve their shape and the quality of the flesh, whilst their peculiar tendency to fatten might still be preserved. We seldom find any artificial food used in this county for fattening cattle—hay and turnips being generally employed; but its judicious use would pay in the beast fattened and the increased value of the manure.

The vales of the Exe and Honiton, with the neighbouring country, are the principal dairy districts. The dairies are not generally large, ten to fifteen cows being the average number kept. It is a frequent practice to keep one Guernsey cow in a dairy of ten or twelve Devons—the milk and butter being much improved in quality and *appearance* by it. In describing the dairy operations, the practice of scalding milk for the manufacture of "Devonshire or clouted cream," will be the first to receive notice. The milk immediately it is drawn from the cow is strained into shallow pans, in each of which about half a pint of water has been

previously placed, and in the winter the same quantity of boiling water is used. The water is employed to prevent the milk sticking to the pan, by which it would be burnt and thereby rendered useless for the manufacture of cream. It now remains undisturbed in the dairy 12 or 24 hours, according to the state of the weather. Thus in *sultry* weather the morning's milk is scalded in the evening, whereas, under ordinary circumstances, it would be retained until the following morning and done with the previous evening's milk. The process of "scalding" is performed by various means, generally over a small charcoal furnace, occasionally on a clear wood-fire, or by a warm water-bath. By the first plan the pans are placed on the iron-plate which covers the flue of the furnace, and moved slowly towards the fire so as *gradually* to increase the heat of the milk. This usually takes from 40 to 50 minutes; and too much haste is a frequent cause of failure with persons unaccustomed to the practice. The period for removing the pan from the fire is indicated by the appearance of small bubbles under the "head" of cream, giving the surface a dimpled appearance. It takes place at the temperature of 180° Fahr., which is several degrees below the boiling-point, to which, if the heat should rise, the cream formed on the top is broken and the milk is spoiled for this purpose. When the milk is removed it is replaced in the dairy, and care taken to preserve the surface of cream unbroken. It is skimmed from 12 to 36 hours after, and the cream either sold in its present state or made into butter.

When the milk is scalded over a wood-fire the cream is liable to have a smoky flavour if by any chance the fire should not be perfectly clear. It is never followed in preference to other methods. The use of a water-bath for this operation is far from common; but as it is extensively used and is not only the *safest* but the *quickest* mode of precedure, I am induced to describe it. A flat boiler made of sheet-iron (2 feet wide, 7 feet long, and 1 foot in depth) is fixed over a large flue in which rough brushwood or furze is burnt. A quantity of *cold* water is placed in the boiler and three pans of milk are supported in it by means of rings, which increase in temperature with the water by which they are surrounded. It is evident that the heat is raised far more *gradually* than can possibly be effected by the most careful movement of the pan towards the fire. Another advantage which results from this method is *greater expedition*, which is very important in the summer months, as butter made from cream *slowly* formed will not keep so well as that made with a shorter exposure to heat. The extent of surface in the milk-pans produces a large "head" of cream; but *the depth of the milk* in the pans and *the firmness of the cream* increase in the same proportion.

6 or 8 quarts of milk is the quantity operated on in each pan, but in some dairies 12 quarts are used. In general 8 quarts of milk will yield 1 pint of "scald or clouted cream."

The butter is quickly made from this cream by working the cream in a small tub by means of a stick, and is superior in every respect to *raw cream* butter. In those dairies where much butter is sold in barrels, they generally make it with equal quantities of raw and scald cream, being the most productive, obtained with the least expense, but inferior in quality. By the above process of "scalding" milk the butter is very completely removed in the cream, consequently the milk which remains is very poor and forms inferior cheese.

### *Sheep.*

Sheep-farming is not extensively practised in Devonshire, but receives most attention in the central and eastern portion of the county. The sheep are generally crosses of the Old Bampton breed with the Leicester or Cotswold. The degree to which the delicate nature of the Leicester may be introduced is regulated by the character of the land. Should it be of good quality and well sheltered the Leicester may be found nearly pure, but the proportion decreases as the exposure becomes greater, and is ultimately superseded by the Cotswold. The South Downs have been introduced, but only on some of the best sheep farms. The horned Exmoor breed are occasionally met with in the north of the county, but they do not possess any advantage over a *judicious* mixture of the Bampton and Cotswold, or sometimes the Leicester. When early lambs are required the Dorset breed are used, but are seldom sought after for this purpose, except when reared as house lamb. The lambing season commences in the early part of February, but with a Dorset flock in October or November. The wether hogs are sold fat at eighteen months or two years old, weighing from 18 to 22 lbs. per quarter, but some farmers dispose of them at this weight when twelve months old. The ewes are sold fat when five years old, and average from 26 to 30 lbs. per quarter. The weight of a fleece of wool in the yolk is about 8 lbs., but it *rarely* obtains a good price in the market. This results from the sheep being shorn without previous washing, which increases the weight of the fleece, but the price is proportionably reduced.

The Oakhampton sheep are general on the borders of Dartmoor. They graze during the summer and autumn on the short grass with which the moor abounds; are removed to more sheltered spots during the inclement weather of winter, and fed on turnips. The wethers are fattened when four or five years old, and weigh about 14 or 15 lbs. per quarter. The delicacy of this mutton is justly valued by connoisseurs.

The advantages of sheep-farming are not duly appreciated in Devonshire, as the farmer may thus save much labour in the conveyance of manure, and the management of sheep in the neighbourhood of the downs and wolds affords many points of improvement which are worthy of imitation.

### *Horses.*

These are small, strong, and active, for the land being for the most part hilly, it is found advantageous to have them *rather under* the ordinary size, as being better adapted for the work than large and heavy horses. They are worked eight hours daily, being allowed during the summer months to rest from twelve till two o'clock, but in winter complete the day's work without stopping.

The practice of using pack horses is seldom followed except on hilly ground or in woods, for the removal of fagots, bark, &c., which are inaccessible by carts. In the neighbourhood of Ashton, Holcombe Burnel, Dartmouth, &c., "dung-pots" are frequently used for the conveyance of manure to sheep land. The "dung-pot" differs but slightly from the pack, and both are carried on the back of the horse. It is found necessary in these parts to replace the earth which has been washed from the higher to the lower ground, in order that the *very thin soil* upon which they have to work may not be *entirely* removed. This being done every six or seven years involves a large expenditure of labour, but it is absolutely necessary if such land is to be maintained under the plough. If laid down in grass it would yield better remuneration, and its place could be well supplied by breaking up some of the pasture land, which is now preserved as such, at no trifling loss to all classes of society.

### *Pigs.*

The pigs which are reared in this county are well bred, and judgment has been shown in the various crosses. In the north of Devon very few are fattened for bacon, but large numbers are sent to London as porkers from three to six months old. In the dairy district the largest proportion are reared and fattened, as this is an important source of profit in a well-managed dairy. They are fattened when eighteen months or two years old, and average from 15 to 20 score. Until recently the potato was largely used for feeding pigs, but circumstances now compel us to seek a substitute. The value of the potato as a *nutritious* food (or for the formation of muscle or flesh) is much inferior to others in general use, yet its fattening properties render it valuable. This root, with barley meal, produces bacon of the best quality, for we have in the latter sufficient to supply the waste of the body by forming

flesh, whilst the potato acts as additional matter to be converted into fat, for which its composition renders it very suitable.

The swede and mangold wurzel have been much employed since the commencement of the present potato disease. When these roots are boiled or steamed, the water with which they have been cooked should be carefully preserved, and given to them mixed with meal. It is doubted by many persons if any advantage is derived from feeding hogs with steamed food, but we can soon form a correct opinion on this question. The body present in the swede or mangold wurzel, which produces fat, is *sugar,* which is easily *dissolved in water,* but in the potato it is found as *starch* which is *not soluble;* if, however, the latter is either steamed or boiled it bursts its envelope and will *then* be readily digested. Hence we should expect but little advantage from cooking the swede and mangold wurzel, whilst it is essentially necessary for the economical consumption of the potato, and this opinion is supported by practice.

### *Poultry.*

The rearing and feeding of poultry is much attended to in this county, and a large number of turkeys, geese, ducks, and fowls are forwarded to the metropolis. The general character of the poultry is that they are smaller than the ordinary size, but *exceedingly delicate.* From the neigbourhood of Hatherleigh, Torrington, and the dairy district, the largest quantities are obtained, and the entire produce of the year is frequently purchased by houses in London, and fixed quantities are sent periodically according to agreement. The regularity and speed with which poultry are now conveyed by means of the railroad increases the demand from this part. Butter, cream, and young pork are also supplied under similar conditions. The general management of poultry differs but little from the ordinary practice of other parts.

### *Enclosures.*

The enclosures of Devon are very small and the fences larger and more frequent than necessary. This subject has been fully considered in an Essay by Mr. Grant* of Exeter, and the data therein contained are worthy of confidence, being the result of actual measurement. This survey extended over 37,000 acres, within a circuit of 15 miles round Exeter, and was confined to land under tillage. In this extent there are 1651 miles of hedges occupying 2642 acres, or $7\frac{1}{7}$ per cent. The average size of the fields is 4 acres, 2 roods, 22 perches, and out of 7997 enclosures (the whole number surveyed) 7670 were less than 10 acres, and

* Journal of Royal Agricultural Society, vol. v., p. 420.

this district is a fair specimen of the enclosed land of Devonshire. The land occupied by the hedge does not afford a correct idea of the extent of surface rendered unproductive by it; the produce on either side is less in quantity and inferior in quality; moreover, the numerous enclosures render cart-roads of frequent occurrence. These additions will at least double the per centage previously named, and more clearly proves the immense loss sustained: they are, however, too frequently made a subterfuge for neglecting a more perfect tillage of the land. The removal of many of these hedges would be a mutual advantage to landlord and tenant: to the former it would be a clear addition to his productive property, increasing the annual value of his estate, whilst the latter would derive equal benefit although in a more indirect manner. Much is done at the present time towards the enlargement of enclosures and rendering their boundaries more regular.

The supply of fuel was one great inducement for making so many hedges, the difficulties in obtaining coal being *then* almost insurmountable. But the principal motive was the fact, confirmed by daily experience, that small pastures will support more cattle than an equal extent in larger fields, and afford more* shelter to the stock. Local circumstances can alone determine the point at which these advantages are counter-balanced by the expenses incurred in their obtainal, for climate and the fertility of the soil regulate the practice.

On an arable farm hedges occupy a very different position—they shelter birds, vermin, and *other destroyers of our crops*—the land is impoverished by *the roots* of their trees—vegetation suffers from *their shade,* and they supply numberless weeds to our fields, all proving that their number and size may be diminished with advantage. On the other hand, in some parts of the north of Devon, where the land is poor and much exposed, a further subdivision is desirable.

### *Woods and Plantations.*

Elm, oak, ash, beech, and sycamore are the chief varieties of timber grown in Devonshire. The elm grows in a most luxuriant manner, and successfully rivals other parts of this kingdom in the quality of its timber. These trees flourish most on the red sandstone formation, and they decrease in number and quickness of growth as we leave this geological formation. In the south of the county the oak and ash are the prevailing timber of the district.

The principal part of the wood is grown in the hedges; the coppices and plantations are of small extent. It would appear

* In some hilly districts, but not in the valley, unless the divisions are of iron or of post and rails.—Pн.

almost needless to state one argument against a practice which is so manifestly incorrect, did not observation lead to an opposite conclusion. The growth of hedge timber is an unprofitable speculation, because the *cultivated* crops are injured to an extent which the value of the timber will never repay; and although the landlord may not be sensible of this loss, yet as it is a burthen on the occupier of his property he must indirectly experience it. I am convinced, if landed proprietors would fairly consider the merits of this practice, its inconsistency would be admitted and the evil quickly remedied.

The management of underwood and timber is very defective, even on land solely appropriated to their growth. Cattle commit depredations which a well-kept fence would prevent, and the general condition of the boundaries would lead a person to conclude that the damage thus sustained is considered unworthy of notice: this is one of the many instances of *ill-timed parsimony* here observed. The increased vigour of the stools will repay the cost requisite to preserve them from rabbits, hares, &c. during the various stages of their growth, especially the first year's shoots, to which they are particularly injurious, producing a *bushy* wood, which never attains the full height. Stagnant water is a serious impediment to a vigorous growth of wood, and should always be removed by open drains. By proper attention to these and other points of good management a growth of underwood may be obtained on land of ordinary character worth from 16*l.* to 20*l.* per acre when ten years old.

Many of these observations are equally applicable to plantations; for attention to regularity in the distance of the trees, and their periodical thinning and pruning, &c., would meet an abundant reward in the increased value of the timber grown. Let the majority of the hedges be removed—let the timber for future years be raised as any other crop, *on land solely devoted to it*—and, whilst the value of estates would be increased, a superior timber would be produced at less cost.

### *Waste Land.*

The extent of waste land in this county has been stated to be 454,400 acres, much of which may be rendered productive, and would afford a large amount of employment to the labourers, many of whom are, during the winter months, supported by the public rates. I shall, therefore, enter more into detail, in the hope that more attention may be given to the subject.

*Dartmoor* is the largest area of uncultivated land in Devonshire, occupying no less than 250,000 acres, or more than half of the waste land in the county. The soil is principally peaty, which, during the summer months, is dry and firm; in other parts, as in

Dartmoor Forest (which is 80,000 acres), there exists a perfect bog, or swamp, even in summer. The soil rests on granite, portions of which are seen protruding above the surface, and are provincially termed Tors. Dârtmoor is very much elevated, being at a mean height of nearly 1800 feet above the sea. The climate is cold throughout the greater part of the year, and materially impedes vegetation. As I have previously stated, the cause of this peculiar climate is the want of drainage. The subsoil is impervious to water—all that falls on it, either from rain or the condensation of vapours, is compelled to pass away on the surface; the soil becomes thoroughly saturated, and its evaporation produces an extraordinary degree of cold. In those parts where the outlets are imperfect (as is the case in the Forest) swamps are formed; but where the water has a clear passage the land becomes dry during the summer months. There are extensive tracts which possess a porous soil: they were formed by the decomposition of the granite rocks, are of good quality, and might be quickly brought into a productive state. Very little of Dartmoor has been brought into cultivation. The great difficulty the agriculturist has here to contend with is the severity of the climate. Private individuals can exert but little control over the climate of such an extensive district, and great difficulties will have to be encountered until the whole surface is more perfectly drained.

*Haldon and Woodbury.*—These are tracts of waste land having a sandy soil, with an intermixture of peaty matter. The attempts which have been made to bring them into cultivation have remunerated the parties engaged. The pieces which have been cultivated are now in a productive state, and offer encouragement for more extended occupation. On Woodbury a mere acknowledgment is paid for the first twenty-one years, and afterwards 5*s.* per acre as an annual rent for an agreed period. Firs thrive very well on this land, and the greater part might be advantageously planted.

The next portions of waste land to be noticed are parts of the carboniferous deposits principally near Hatherleigh, Holsworthy, and South Molton; also between Exeter and Moreton. This land requires draining, without which it would be a useless expenditure of capital to attempt its improvement. A large proportion is too poor for everything but timber.

### *The Management of Landed Property*

Has an important influence on the farmers of any district, and I shall briefly notice some of the prevailing defects in this county. One of these is the use of leases containing clauses that restrict the farmer in his operations, and often compel him to act contrary

to his better knowledge. These might have been adapted for the times when first introduced; but the improvements which have taken place in agriculture render them useless, if not mischievous, and modifications of these restrictive clauses are much needed. They have been adopted to protect property from injudicious management; but, stringent as they are, *in this they have failed.* On the other hand, without the protection of a lease, an equally powerful obstacle to good cultivation presents itself. The tenant does not improve his farm, because he is fearful of an increase of rent or the loss of occupancy—he neglects to improve the value of his farm by good husbandry and an outlay of capital—he therefore satisfies himself with such a cultivation as will yield a return for his own maintenance. It is unreasonable to expect a tenant to improve the property of another person unless he has some security for the outlay of his capital. Give him this security, and free him from the shackles of such leases, and he will occupy a position in which he can exercise his knowledge, skill, and capital to his own and to his landlord's advantage.

A still greater evil remains to be noticed in the practice of letting land to the *highest bidder,* who is commonly the one who has least to lose. A man with good capital is cautious how he bids beyond the *real value* of the land; but he who has little at his command will generally be the most forward in his offers; and too frequently the landlord, induced by the high rent, accepts his proposals. As a result, the land is very imperfectly cultivated, from a deficiency of capital and judgment—it is overcropped to raise money to pay rent and other expenses; and, to say the least, all improvement is hopeless. Another disadvantage of this system of letting land exists in the case of the honest farmer who, having no other means of gaining a living or of employing his small capital, is compelled in self-defence to take a farm above its value. After struggling for many years to meet his payments, he finds his capital fast sinking—he becomes dispirited—and in the end his rent is lowered, or he quits the estate. The high rent is not maintained, and the land, so far from being improved, rapidly diminishes in value. These cases *are not of rare occurrence*—hundreds of farmers in this county are at the present time in such a position—it is therefore important to bring these evils under public notice. Under the same circumstances another class are satisfied if, at the end of the year, they are not *worse* off than at its commencement. But why should not the farmer obtain interest and profit on his capital as well as the trader or manufacturer? Many do not even realize the usual interest of money, although they continually bestow time and attention to their calling.

How different is the case where the landlord, selecting his tenant for his judgment and capital, gives him *proper freedom and*

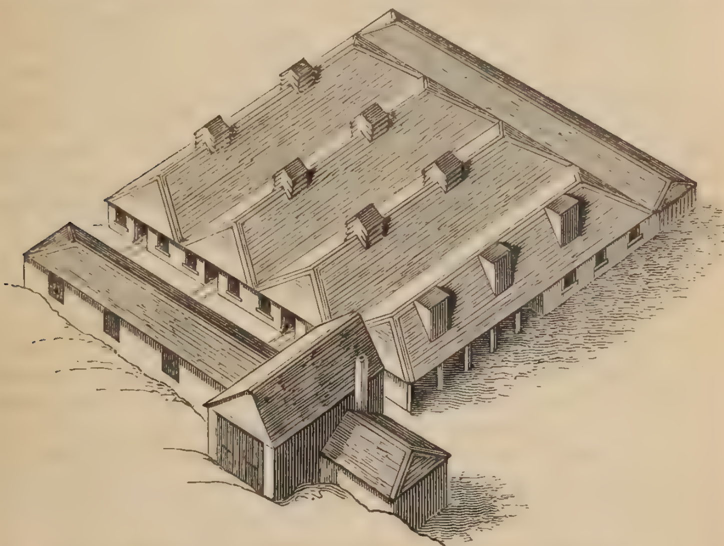
*security* to induce their expenditure. The land is improved in its character—its value increases proportionately—it will yield an increased rent, and all proceeds favourably. But what is the cause that such is not more generally the case? Undoubtedly because the management of estates is too often placed in the hands of persons deficient in the qualifications for their office, and ignorant of the best system of cultivation. A survey of the county will corroborate this assertion; for where the management of property has devolved upon men accustomed to a good mode of farming, the tenants are found in a more prosperous condition. Being competent to judge fairly between landlord and tenant, they protect the interests of the former, at the same time induce him to grant what justice demands for the occupier of his land, and there are very few (landlords) in this county who would wish to withhold it. In those cases where gentlemen reside on their own property, and take an active interest in the welfare of their tenants, these evils are beneficially checked.

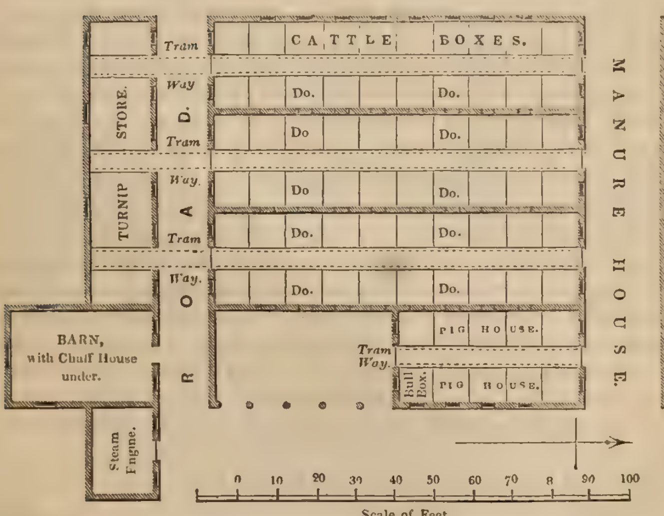
### *Farm Buildings.*

The farm buildings are in the majority of cases very irregularly and badly constructed, and a good homestead is rarely met with in any part of Devonshire. They are generally built with cob-earth (a material which will be noticed in a later part of this Essay), and allowed to become dilapidated and much out of repair. Thatch is usually employed as a roof, but in new erections slate is preferred, being considered the most economical as well as the neatest and safest covering. The homesteads appear to have been built *without any regard* to uniformity or convenience; and it is probable that when additional buildings were necessary they were raised on the nearest spot that happened to be free. The stables and sheds for live stock are low and imperfectly ventilated, giving rise to various diseases. The yards are generally on the sides of hills, and the soluble part of the manure is thus readily washed away by the rains, although in most instances a small outlay would remedy the defect.

The providing of sufficient farm-buildings is one of the first duties of a landlord: it is not his interest to allow the tenant's capital (often too small for his occupation) to be expended in their erection, seeing that it might be *more profitably* employed in the better cultivation of the land. The landlord should build, the tenant pay interest on the money expended, and be required to keep them in repair. Thus all the ordinary "wear and tear" would fall on the tenant, but the first outlay on the landlord. The additional amount of rent thus thrown upon a farm would be gladly paid by the occupant, who would be a decided gainer from all his operations being concentrated and more economically performed. This has been done in a few instances in different

parts of the country, but in general they remain in a deplorable condition. Those lately erected on the property of the Duke of Bedford near Tavistock are conveniently and economically constructed. The homestead built by Mr. Fowler at Prince Hall, Dartmoor, presents many points of originality, and, although too costly for general adoption in this county, is in many respects worthy of imitation. An isometrical drawing and ground-plan of the feeding department of this homestead accompanies this Essay:





the plan was designed by Mr. J. C. Morton of Whitfield. The mode here practised for making and preserving the manure deserves the attention of Devonshire farmers, as it differs entirely from the ordinary practice of the county. The cattle fed on this estate are kept in boxes constructed on Mr. Warner's system, by means of which all the liquid portions of the manure are absorbed by the litter, and nothing is lost by drainage or fermentation. When the pits are full the dung is removed into the manure-house by means of a truck or a tram-road. It is here secured from the destructive influence of the rain and sun until required for the land. The economical consumption of food, and the improvement which better accommodation will make in the farm-stock, are powerful claims for the more perfect construction of farm buildings. It is absolutely necessary that the present buildings should be superseded by others of more complete character before the farming of Devon can make any great advances towards improvement. Indeed a properly constructed homestead is absolutely necessary on a well managed estate.

### *The Condition of the Agricultural Labourer.*

The mutual dependence of all classes of society is a bond of union which so intimately connects them together that anything which acts favourably or unfavourably on one class is felt by the others. The proprietor of land, the tenant, and the labourer have each the duties and responsibilities of their several stations to perform, and the neglect or abuse of these produces a proportionate disorganization in society. It is much to be regretted that circumstances exist which have a prejudicial influence on all, arising solely from an imperfect performance of these duties. Few persons will assert that the comforts of the farm-labourer, both as regards food and lodging, are such as he should enjoy, or that his mental improvement has been properly attended to.

The employment of this class is at present too fluctuating, and a remedy must be sought for this evil before the labourer's condition can be permanently improved. Through some parts of the year he can obtain full employment, but during the months of winter and early spring it is often the case that the industrious labourer, unable to find work, is compelled to seek relief from the Union. The improvement of landed property would *give employment to all,* and at the same time *benefit both landlord and tenant.* It is generally admitted that when a master is a good judge of work, and is willing to give a fair price for labour, that payment by the piece is advantageous to both parties and especially appreciated by the labourer; skill and industry here meet their reward, which rarely occurs when day-labour is practised. The wages of an ordinary farm-labourer in this county is 8*s.* or 9*s.* a week, with 2 or 3 quarts of cider daily. The manual

operations of the farm are principally performed by men, and although women frequently work on the land, yet their employment is far less prevalent than in neighbouring counties; the manufacture of lace giving employment to a large number of females, which, although rather less remunerative, is more suitable for them.

The dwellings of the farm-labourers vary much in quality: some present every appearance of cleanliness and comfort, whilst many are wretched hovels quite unfit for the occupation of man; within a few years the latter have decreased in number, and in some instances their places have been supplied by others sufficiently commodious. The small number and the untenantable state of many of the cottages compel a large proportion of the workmen to reside in the nearest town or village—a circumstance unfavourable to his comfort and morals, as well as those of his family, and a loss of time and labour to his employer. Here we find discomfort at home drives the father to the ale-house; the sons, from a similar cause, forsake their homes, and meeting with others similarly circumstanced they too often congregate together and lead each other on to the committal of crime, and facts of daily occurrence unfold to us the gross immoralities that arise from such a state of things. Contrast with these the condition of the labourer who occupies a comfortable cottage, with its adjoining allotment of land, a corresponding degree of decency and order is observed in his conduct and that of his family; he feels he has a home to enjoy, a character to lose, that he occupies a station in society, that he holds a situation in which his happiness is centered; whilst the former, lowered to a degree that overcomes his better desires, and unable to free himself from his degraded position, becomes heedless of his course, as the prison or the workhouse can scarcely afford a harder lot than he now endures. It cannot be too forcibly impressed on the minds of the proprietors and occupiers of land, that in the same degree as we increase the comforts of the labourer's home, and lead him there to centre his affection and happiness, so shall we render him a more sober, attached, and industrious servant. Humanity and justice alike demand that our exertions should be used for promoting the comfort of our dependants, for it is by their labour and industry that we receive remuneration for our capital and judgment:—

O give these sons of poverty their cots,
Attach them fondly to their native spots;
Amidst their thorny paths entwine a flower;
Theirs soft submission, thine attempered power.

It may now be interesting to notice any peculiarities in the construction of cottages in this county, and to see in what manner

a landlord would be affected by new and commodious erections. The material commonly used for the walls of cottages is provincially called "cob-earth;" it is made by mixing 3 bundles of straw with 2 cart-loads of sharp or gravelly soil (red sandstone is very good for this purpose); the whole is well wetted and afterwards trodden by men or horses. A foundation of stone having been raised 2 feet above the ground, this mixture is laid on it to the depth of 18 inches or 2 feet, and remains until it has become firm. The length of time necessary for it to harden is regulated by the weather, and also by the soil used; if it should be a free soil and the weather fine, it requires seven or eight days; but if heavier, closer in its texture, and containing clay, the time will be proportionately increased. A second layer is then placed on the former to an equal depth, and thus (always observing the precaution of having the previous bed of earth hard before any more is laid upon it) the walls are raised to the required height. They now present the appearance of a stack of straw rather than a part of a human habitation. The roof and other woodwork having been completed, the walls are trimmed by cutting them smoothly with a common hayknife; a coat of plaster is now applied to both sides of the wall, and the inside receives a second coat. Before this becomes dry it is "rough cast," by portions of fine gravel being thrown violently against it by which much adheres to the surface. A coat of whitewash generally finishes this part of the building. This material ("cob-earth") is used alike for the dwelling of the peasant and the residence of the more opulent classes, and is equally adapted for the cottage or the mansion. By strangers to the county, as well as by many who, although residing in it are unacquainted with the value of these walls, they are contemptuously designated *mud* walls. But by whatever name they may be distinguished their intrinsic worth remains unaltered; for the most durable, healthy, economical, and comfortable wall for a building is that made with *good* cob-earth. It appears to form a strong concrete, which will equally resist the action of the atmosphere and climate with our best building stone. In building a large house, it should be commenced in May, so as to have the heat of the summer months for hardening the walls. The advantage of increasing the height gradually is to prevent bulging, which would necessarily result if the weight were laid on the top whilst the previous layer was yet moist. For a low building the wall may be 18 inches thick (when trimmed), but for a cottage or house it should be 2 feet; the walls of old erections are often as much as 3 feet in thickness. The materials and labour for a cottage wall cost 3*s*. per perch (16½ square feet).

The lime-ash floor is also peculiar to this county; it is formed from a composition of lime and sand, mixed in varying propor-

tions, according to the character of the former. Thus, the lime of Sandford does not require any mixture of sand, and forms the hardest floors of the kind; if the lime forms a good mortar, or what masons term a "brittle mixture," it may be employed for these floors. The proportion of sand should be such as will form with the lime a good mortar for plastering walls; this mixture is poured on a layer of stones (of the size of good road metal) to the depth of 4 or 5 inches, and remains until moderately hard, when it is occasionally beaten by heavy pieces of wood with large flat bottoms. In about three months from the time of laying it has the hardness and durability of stone, and forms a very permanent floor: but until it has attained this firmness it must not be used. The usual price for this floor when complete is 1*s.* a square yard. The kitchen and dairy floors of farm-houses are generally formed in this manner, and for these it is certainly *much superior* to any other material.

The roof is, with few exceptions, made of thatch, which, like the cob-earth wall, tends to maintain an equable temperature within the building, however severe the changes without. The use of reed (instead of straw) diminishes many of the objections raised against these roofs, and if their durability could be increased and their liability to fire diminished by any available process it would form the best covering for a labourer's cottage.

The cost of a substantial cottage with good cob-earth walls, slate or tile roof, and containing four rooms of convenient size, with the requisite out-buildings, is 50*l.* If several are built together they can be raised at less expense; thus six cottages might be built for 250*l.* Supposing the capital thus expended to pay 6 per cent., the labourer may be supplied with a comfortable cottage for 1*s.* a week, which is the sum he now pays for a dwelling as inconvenient as it is unhealthy. To each cottage a quarter of an acre of land *(adjoining)* should be allotted as garden ground, for which a *moderate rental* may be charged.

### *General Observations.*

Many of the peculiarities of Devonshire farming may be traced to the climate, which has been shown to be very favourable for the cultivation of roots and green crops but detrimental to the growth of corn. Hence the cause that so much attention and capital are devoted to the rearing of cattle, for which the abundance of grass and other green food offers singular inducements. The tillage of the land is chiefly attended to in those parts in which the soil is naturally dry, thereby counteracting the unusual amount of moisture with which the county is supplied. The relative value of different breeds of cattle is also dependent (in some degree) on local climate. Thus, the north Devon breed

fatten best in the colder districts of the county; but in the south of Devonshire the South Hams cattle excel them in this respect. The conflicting opinions as to the superiority of different breeds of cattle and sheep arise very much from this adaptation to climate not being sufficiently considered. The almost exclusive attention paid to the rearing of cattle is probably the cause of the extremely injurious course of cropping so generally adopted. When the farmer is anxious to obtain a few crops of corn, he prepares his land as quickly as possible. A crop of roots having been raised and either partially or entirely consumed on the land, he sows his first corn-crop, which is generally wheat. This is followed in immediate succession by barley and oats; the land, being then too much impoverished for another *remunerating* corn-crop, is laid down in grass, as the cheapest mode of recovering from the injuries such an injudicious mode of cropping has occasioned. Whilst the land is under tillage it is his endeavour to obtain the *largest returns* of corn at *the least possible expense,* and he would be justified in the attempt did he also remember another principle of good farming—of doing it with *the least injury to the land.* This, however, is quite lost sight of, and the poor pasturage which the land afterwards yields fails to convince him of its importance.

*Agricultural Improvements.*—The remote position of this county and the pecuniary circumstances of a large proportion of the farmers prevent any extensive intercourse with the better farmed districts of England. Moreover, a large number of Devonshire agriculturists reside on their own estates, and being in easy circumstances *have little spur for improvement.* Another cause—the defective education of young farmers—is more radical and influential. If a youth is destined to be a tradesman, he receives a good foundation for his after attainments ere he leaves school; if for a farmer, the mere elements of knowledge are considered sufficient. Happily that day is now passing away, and will in future be known only on the page of history. Agriculture is now to be looked upon not only as an art but also *as a science,* not separated by that boundary which has hitherto existed to the injury of both, but *united in the practice of the same individual;* and thus their contending animosities will now be devoted to the subjugation of ignorance and their mutual promotion. Give the rising generation of farmers a better education, encourage them to avail themselves of the advantages which the labours of scientific men have placed within their reach, and you adopt the surest means of removing the prejudices now so predominant. Until very recently, to gain a knowledge of the sciences connected with agriculture was a task encompassed with difficulties which *few* could surmount; but the establishment of the Royal Agricultural

College completely removes these obstacles, and cannot fail to give a stability to scientific agriculture in which it has hitherto been sadly deficient.

The interest which many of our largest landed proprietors have manifested of late years for the improvement of Devonshire farming has been successful in inducing their tenants to give some attention to the few improvements which have been introduced amongst them. Much of the reluctance to vary from the established modes of husbandry may be attributed to the circumstance that the whole of a farmer's capital is generally expended on the land he cultivates, and that *a rash pursuit of new theories* would involve him in complete ruin. This, although a reason for caution. does not justify the determined opposition to well-established improvements which is frequently manifested.

The formation of farmers' clubs in this county and the spirited manner in which they are supported affords pleasing proof that a desire for improvement is awakened. By their agency much valuable information is diffused, which must have a favourable effect on the agriculture of the districts where they exist, and they merit the support of all classes of society.

It cannot be denied that the farming of Devon is at the present time inferior to that of most of the counties of England; and it is the object of this essay to induce the agriculturists of this county to consider the defects that remain rather than lead them to rest satisfied with the few improvements they have adopted. The advantages which this county possesses in a genial climate and a fertile soil needing only the application of greater capital, industry, and skill, encourage the hope that Devonshire will before long reinstate itself in the position it held in the sixteenth century, when it was an example of the best farming of the age.

*Addington Park Farm, near Croydon.*

## XXVI.—*On the Farming of the North Riding of Yorkshire.* By M. M. Milburn.

### Prize Report.

If a traveller were passing through the North Riding of Yorkshire, by either of the lines of railway by which it is intersected, he would be likely to arrive at the conclusion that it was an ill-cultivated district. The inference would however be an erroneous one, because the two railways happen to pass on low levels, and in districts where the land is generally undrained, whilst the best or high-lying portions are necessarily hid by cuttings; and as valleys generally, except on alluvial deposits, are the inferior soils, and the most difficult to cultivate, they hence will usually be found to present a sample of cultivation exceedingly unfavourable. Although it must be admitted that parts of the Riding are decidedly behind-hand in farming, there are some districts where Science could scarcely, in her very advanced state, suggest any improvement.

The North Riding of Yorkshire presents as great a variety of soil and cultivation as most districts of a similar extent, and in few are the details of farming more remarkably modified by the geological character of the strata on which the soil rests. To the extreme west of the Riding, the grass valleys and hill-sides on the mountain limestone, present grass land so valuable as to let for as much as 4*l.* per acre in that isolated district, where the only profit is to be made by ordinary farming. Proceeding east, lies an ungenial belt of the millstone grits and limestone shale. Next a wavy belt of the red sandstone, with a slight intervention of the magnesian limestone, and next another, curving over to the north-east, of the lias; then a similar and somewhat parallel belt of the oolite. The whole may be described as a series of wavy strips, in some cases broader, in some narrower, but several much modified by aspect and situation. The soil divides itself, with these modifications, much in the same manner. Thus the red sandstone presents the "turnip and barley soil" almost precisely co-extensive with the stratum on which it rests; and where one systematic and uniform management prevails, unpractised only for a want of skill, or, far more generally, a want of capital. The lias, co-extensive with the district called Cleveland, but still bending away at the foot of the Hambleton Hills—cold, heavy, and designated "two-crop and fallow-land." The limestone, where arable, partaking again of its peculiar cultivation, and where grass, modified by its cover, thin or otherwise, of the soil resting on it; while in the valleys of the north-east and east scarcely any

OUTLINE

OF THE

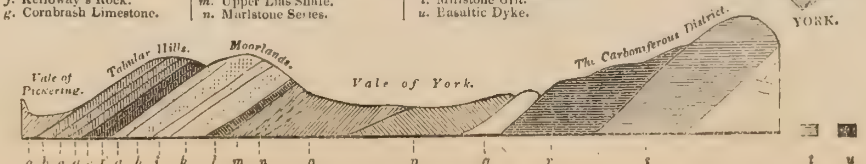
GEOLOGY OF THE NORTH RIDING

OF

YORKSHIRE.


## GENERAL ARRANGEMENT OF STRATA.

*a*. Kimmeridge Clay.
*b*. Upper Calcareous Grit.
*c*. Coralline Oolite.
*d*. Lower Calcareous Grit.
*e*. Oxford Clay
*f*. Kelloway's Rock.
*g*. Cornbrash Limestone.
*h*. Upper Sandstone, Shale, and Coal.
*i*. Oolite Limestone (Bath).
*k*. Lower Sandstone, Shale, &c.
*l*. Ferruginous Beds.
*m*. Upper Lias Shale.
*n*. Marlstone Series.
*o*. Lower Lias Shale.
*p*. Red Sandstone.
*q*. Magnesian Limestone.
*r*. Coal Measures.
*s*. Mountain Limestone.
*t*. Millstone Grit.
*u*. Basaltic Dyke.




## REFERENCES TO PLACES ON THE MAP

1. Bowes.
2. Rokeby.
3. Kexwith.
4. Richmond.
5. Reeth.
6. Feetham.
7. Muker.
8. Askrigg.
9. Hawes.
10. Carperby.
11. Burton.
12. Middleham.
13. Ellingstring
14. Middleton Tyas.
15. Hipswell.
16. Cowton.
17. Appleton.
18. Danby Wiske.
19. Catterick.
20. Northallerton.
21. Scruton.
22. Snape.
23. Burniston.
24. Masham.
25. Melmerby.
26. Skipton.
27. Topcliffe.
28. Borrowby.
29. Thirsk.
30. Borobridge.
31. Easingwold.
32. Brandsby.
33. Haxby.
34. Flaxton.
35. Slokesley.
36. Eston.
37. Byland.
38. Coxwold.
39. Gilling
40. Terrington.
41. Brompton.
42. Egton.
43. Helmsley.
44. Kirby.
45. Roseberry.
46. Nab.
47. Hambleton.
48. Sheriff Hutton.
49. Bilsdale
50. Bransdale
51. Farndale
52. Rosedale

(49–52) Valleys.

definite system of culture prevails. This is not difficult to account for. If we take the Vale of Pickering and the Ryedale Valley, we have the authority of Dr. Buckland for stating, that if it were not for the pass at Malton, the whole of the two valleys would be an extensive lake. A state of things like this will necessarily induce a great variety of soils. In some cases the stagnant water and decayed vegetables will form a deep stratum of peat, and cover the original rock for several feet; in another, the calcareous matter will be washed over in irregular degrees by the streams flowing down the precipices, while in others the aluminous matter will, from the same cause, preponderate; and thus we have every modification of cultivation, and all attempts to classify here, would be attended only with confusion, because so many different plans of cultivation and so many such divisions would be discernible, that it would be best described by saying it is without any system at all.

With a view to classify as far as possible, we will take, first, the four-course system of husbandry, as adopted on the red sandstone series, and where near the surface, on the magnesian limestone and millstone grit; secondly, the two-crop and fallow system, as pursued on the lias and a portion of the oolite; thirdly, the grass management on the hill-sides and valleys; and, fourthly, the medley of cultivation adopted in districts where, from varieties of soil, aspect, or the prevalence of stagnant water, scarcely any definite system can be said to apply to any one considerable tract of surface.

### 1. *The Sand and Gravel District.*

This stands out prominently as the best cultivated part of the Riding. Whether taken as yielding the largest portion of produce—every year bearing its crop, and every crop being productive—or in its keeping its large quantities of stock, and feeding this stock, and withal maintaining itself in a state of fertility, we may say that few instances more generally creditable can be said to occur. Some eighty years ago, or less, this soil was considered not only unfavourable to the growth of wheat, but it was scarcely ever attempted. Rye, or at most rye and a slight mixture of wheat called maslin after fallow, and oats followed, and then fallow again. Occasionally a crop of peas intervened instead of the oats, where the soil was in a state peculiarly favourable. Now, however, there are no open fallows, but the rotation pursued is—turnips, first year; barley, second year; seeds, third year; wheat, fourth year.

*Wheat.*—Taking the last-named crop as being the one specially introduced by agricultural improvement first—the wheat. It may be observed that the usual preparation for wheat is the

seeds. They are broken up generally in the month of October, and ploughed somewhat shallow—from 4 to 6 inches deep. The consolidation and fertilization attained by their being unstirred for eighteen months, and the treading of the sheep, give the soil consistency and solidity; and this is generally now assisted by the operation of pressing, with an instrument consisting of two heavy annular pieces of cast iron affixed to an axle. This following two ploughs presses down the interstices between the furrows, and thus forms a consolidated seed-bed in which the wheat is afterwards sown broadcast, and which falls principally into the furrows. Another somewhat common mode is to apply the drill; and some parties still use the ribbing-plough, which, making furrows of some 4 inches wide, also assists, to a certain extent, the necessary consolidation of the seed-bed.

The quantity of seed varies from 10 pecks to 12 (3 bushels). Experiments have been made, by a variety of parties, with thin-sowing on all descriptions of soils. H. S. Thompson, Esq., of Moat Hall, Colonel Croft of Stillington, Mr. Ord of Melmerby, and the writer of this paper, have experimented with dibbling, thin-sowing, and various modes of departure from the ordinary plans of wheat-sowing. The whole, however, turned out a failure, or nearly so. Several seeds did not germinate; the sample was coarse; the produce inferior in weight and quantity; and the land was found to be unfavourable as regarded weeds. The tendency is therefore not to depart from the practice of sowing at least 10 pecks per acre, and as many as 13 are sometimes drilled on the land. The kind of wheat sown is the old "creeping red." Some eight years ago there was a most extraordinary disposition to try new varieties of wheat. About ten or twelve different varieties were introduced, and obtained some degree of favour; but the great promises held out were not realised, and most of them have given way before the old and long-tried kinds of wheat, and but little advantage on the whole resulted from the change. Occasionally artificial manures are applied to the wheat. Rape-dust, bones, and guano are the chief appliances, but only when there has been some deficiency in the turnip crop, or where a large proportion of turnips has from any cause been pulled off the land; but even these artificial or hand tillages, as they are termed, are not generally in great favour, as there is found to be much greater tendency in the wheat to be affected with mildew where they are used. Top-dressings are more commonly resorted to; and where the appearance of a crop is considered unpromising, or any deficiency is apprehended, the habit is to apply soot, nitrate of soda, or even guano—care only being taken to apply these in a rainy time. I have seen as much as a difference of six bushels per acre increase in a crop by the latter application.

If a dry season occurs, so much is lost in evaporation, or possibly much is never brought into a state of solution, and consequently many descriptions of artificial manures are found nearly useless. The safest mode, it is considered, is to hoe them in, or at least to pass the harrows over the land, which is not found to injure the plants, but rather the reverse.

The smut, once such a pest to the cultivator, is nearly banished. If it makes its appearance at all, it is on some very neglected or ill-cultivated spot. The most usual mode adopted to prevent its ravages is to steep the seed in brine, and to drug it with quick-lime; but the most certain preventive is a solution of arsenic or sulphate of iron, mixed sometimes with salt, applied to the seed, and dried with quick-lime.

The next process to which the wheat is subjected is that of rolling, in the spring, with Crosskill's clod-crusher, where the means and extent of holding will admit of its being employed. The frosts of winter always so lighten the soil that some process of this kind is necessary to afford consolidation sufficient to effect a seed-bed firm enough to bring the wheat-plant to maturity. Many parties hoe the corn in the month of April or May, which keeps down the annual weeds, and exposes a new surface to the action of the air. The practice, however, is not quite general.

The harvest operations are carried on with much more rapidity than formerly. The wheat is harvested much greener—a larger number of hands is employed—the whole, or nearly so, is mown by the scythe—and hence, from its being more rapidly cut, and laying much more open in the sheaves than it formerly did when shorn, it is much more readily secured. Six or seven days is as much fielding as is usually given, and the samples are found to be much improved by early cutting, even while a degree of greenness exists in the straw, for the last process of the plant in ripening is doubtless the formation of a thicker coat of bran. The takers-up follow the mower, and the wheat is invariably covered with "hood-sheaves," or the ears of the corn are covered over by two inverted sheaves. This process is by some carried to such perfection that it is asserted a month's rain will not penetrate the upright sheaves. We may mention the Messrs. Outhwaite, of Bainesse—whose entire operations are conducted in the most perfect manner conceivable,

Hooded "Stook" of Corn.

but who always shear the corn—as being perfect models. The rain much sooner penetrates the mown sheaves, but it must also be admitted that so do the drying winds; and we believe the balance of chances is in favour of mowing corn, as regards safe and early harvests.

The corn-stacks are by no means large—the contents varying from 5 to 7 quarters in one stack. As a large proportion of the wheat remains unthrashed till the spring, it is usually carefully stacked, and temporarily covered with straw during the harvest, until time can be had to thatch the whole. Harvest wages vary from 15*s*. to 18*s*. per week, with meat and allowance for the month of harvest. Little regard is paid to the hours of labour, and in a fine season it is far from uncommon to work from six in the morning to ten at night; and nothing can exceed the hilarity and merriment of the noisy groups working away by moonlight, well knowing how much of the happiness and plenty of themselves and their families depends on the harvest being gathered in safety.

No sooner is the stubble cleared by the hand or horse rake, and the rakings collected, and when dried in heaps, tied up in bundles or carried away loose, than the best cultivators commence cleaning the stubbles for the subsequent crop. The minute division of the soils on these sandstone series, accompanied by great porosity, causes them to have a strange tendency to grow rapidly to couch, quitch, or twitch, as this best of all known weeds is variously called; and no sooner have they the stimulus of a plentiful supply of air by the removal of the crops, than they throw rootlets directly down in the soil, and the longer they are exposed, the deeper the roots will go. If one of these stubbles is examined, so soon as the corn is cut, the couch will be found very near the surface, whereas a month afterwards it will be found several inches deeper, and the whole of the rootlets tending directly downwards.

Hence, instead of the old tiresome process of ploughing deep, leaving this to dry, and again cross-ploughing—burying, in fact, the root-weeds in order to work them up again, and thus wasting all the fine weather in primary operations—a Ducie scarifier, or some other adaptation of a similar description (of which a great variety is now manufactured in the county by Mr. Busby, Mr. Barratt, Mr. Barker, and others), is set at some 3 to 5 inches deep; and loosening just so much of the earth as is necessary to enable the cultivator to get the plant shaken out of the soil, the whole being kept at the top, the harrows are set to work, and this brings us to the preparation for

*Turnips.*—On the cleanness of the land from weeds, or the contrary, depends the degree of clearing necessary to fit the land

for turnips. The almost invariable rule is to burn the weeds. Autumnal cleaners have by far the strongest reasons on their side for this; for those who defer it to the spring have no excuse for burning. A fine autumnal day, when all is dry and favourable, will do more in clearing the land than perhaps a week in the following April; and hence, it is urged, the whole of the available hands should be employed in getting out the weeds; and that it is impolitic to waste time in carting and removing them; and that fire is a ready and always available mode of riddance. No cultivator doubts their value as an absorbent of liquid manure, or in a compost with dung; but too few farmers have the labourers disposable in the autumn to collect them.

Energetic farmers lose no time in getting away as many crops as they can before the wet weather intervenes; and as the wheat is never sown before late in October, and no amount of wet will interfere on soils so porous to prevent it for many days, they disregard this process in comparison with cleaning the land for the turnips; and hence in the spring they find their lands ready for sowing, while the more backward and indolent are only commencing operations.

So soon as the weather prevents further operations, or the soil is thoroughly clean, after the wheat-sowing season, the land is ploughed up from 7 to 9 inches deep; as a general rule, the better the cultivator, the deeper he ploughs. Deep ploughing is found at the first somewhat to require a greater amount of tillage; but when once in a good state it will yield much larger crops than previously, be less affected by drought or wet, and the crops be less liable to lodge. It is no uncommon thing to see three horses abreast ploughing the clean stubbles, which were allowed to lie so over the winter. The effect upon the weeds is remarkable: the autumn-stirring and winter exposure injure their vitality so much that they never make head even if small portions remain in the land.

When autumn-clearing is not adopted, the ploughing goes on about the 5th of November, and the cross-ploughing in March; the land is then harrowed and weeded; again ploughed; harrowed and cleaned, and then the Finlayson's drag is applied alternately with the plough, until the whole is cleared for the sowing—hand-picking being considered necessary some week or two before that period. The manure in all cases is carted out during the frosts in the winter months, generally once turned over, and is fit to apply about the time of sowing. Swedes are usually sown about the 13th of May, or from that to the 30th; yellow Aberdeens about the 15th of June; but scarcely any of the white turnips are sown till the 20th of June. It is a remarkable circumstance connected with the whole of this red sandstone district, that if the white turnip is

sown earlier, it attains a premature ripeness, and never produces a successful or nutritious crop. The difference between swedes and other turnips as regards their sowing is scarcely worth notice. The former have generally the most liberal allowance of manure; they are always ridged, and chiefly sown in small quantities—too small, we think, generally, though they are considered greater impoverishers of the soil than white turnips; but their value in the spring, or in a severe hard winter, is greater than is generally imagined. The manure applied is usually a combination of farm-yard and artificial, in the proportions of two-thirds of the former to one-third of the latter. The rule is, that the farmer will have with ordinary management fold-yard dung for two-thirds of his turnip land—or, in other words, if he had 100 acres of corn, he will have manure for some 34 acres of turnips. They seldom, however, apply farm-yard dung exclusively to any portion, but spread the manure over nearly the whole surface, but in smaller quantities, and apply the artificial manure nearly in the same manner. Bones are almost the universal agent employed in this process, and the increase they have effected may be fairly stated to be one-third over the produce of the district before they were introduced. The quantity applied is, on an average, about 12 bushels per acre, combined with manure generally drilled with ashes, and perhaps on half the area of the district drilled by the Suffolk drill on the flat surface, the manure being previously ploughed in, though a very extensive and growing disposition prevails to sow them in ridges, where the horse-hoe may be more liberally applied. The farmers are every day increasing who apply sulphuric acid to the bones, and thus reduce the quantity of the latter by two-thirds, and with the best effects.

There are few things in which science has more benefited farming than in this application; and though we have observed it applied to wheat with but little success, for turnips it appears to be the most advantageous of any manure so far discovered, guano perhaps excepted. When ridged the turnips are sown with a barrow-drill, which sows one, or at most two ridges at once; and this process on these soils has the tendency to deepen them, so far as the bed for the plants is concerned, to bring the plants directly upon the manure, and give scope for the horse-hoe, which on such soils, both as regards destroying the weeds and stirring and improving the soil, is a valuable implement.

Turnip cultivation is the foundation of all the fertility of the district, and hence great attention is paid to it, and, at all hazards, a full crop of turnips must be secured, and varying crops from 18 to 20 tons per acre are obtained. The greatest care is taken to have the plants singled out in hoeing, and the ridges, 20 inches wide, have plants set at about 7 inches distance. As the greatest

portion is consumed on the land, the object is to obtain moderate sized, firm roots, rather than larger and less solid; and if cultivators who pull off the whole of their produce were to look over the turnip-fields they might be disposed to find fault with their size. The consumers of them, however, know their own wants, and attain them best by less bulky and thickset solid plants.

The seed sown varies from 1½ to 2½ lbs. per acre. Many farmers sow large quantities, on the supposition that they have a greater security against the fly. This great quantity renders the hoeing much more difficult and expensive. Two hand-hoeings are given; and to swedes three, and two horse-hoeings, when they are sown in ridges.

The varieties of turnips are the white Norfolk, the yellow bullock, the Dale's hybrid, and the swede. A few sow red Norfolk and white stone, and Skirving's and Laing's swede; but they are comparatively few in number.

We have observed that the great object sought was consolidation of the soil and manuring. Hence pulling off is the exception, and eating on the rule. Late in the month of October a portion is set off, varying with the number of sheep, and nets or hurdles separate these from the rest of the field. This is called a "break." The turnips outside this temporary fence for a distance of 3 feet are pulled off and carted to the homestead to be consumed by the cattle, and to assist in making the straw into manure; and with this the best farmers give a little cake. The sheep are turned upon this break; and when the tops and portions above-ground are eaten, they are pulled up by a peculiar drag, or "hack," as it is provincially called; an idea of which is given above. The latter is preferred, as it leaves the fibrous roots in the soil instead of bringing them to the surface, because they will not be consumed by the animals. When this break is finished another is given, until the whole are consumed. A few farmers feed off their lambs before they are shorn, but no extra pains are taken with them. Shearling sheep are chiefly fed off, and no turnips are cut until the spring, when the change of teeth in the lambs of the preceding year renders it absolutely necessary. It must be admitted, however, that it is a question whether the North Riding farmers are not in this particular behind those of the West Riding and the county of Nottingham, where slicing the turnips is an invariable rule, and by which the "hoggets" are fed off under one year old.

Turnip Hack.

The turnips being disposed of in this manner, the land is in a state of great fertility, and is prepared for the next crop in the rotation, the

*Barley.*—The plough follows the sheep as rapidly as the weather and circumstances will admit; and instead of deep ploughing, the greatest care is exercised for this crop to plough thin, 3 or 4 inches being considered the maximum. Some farmers even scarify after the turnips, and drag without ploughing, as it is considered unsafe to bury the rich soil too deep. We have not witnessed so much success attend the plan as either to approve of it or observe its general adoption; and we think it scarcely admits of subdivision in the soil sufficient for the barley-plant to be successfully matured. In the month of March another ploughing or dragging across is given; and the clods are harrowed fine, and the soil ribbed or drilled, as may suit the convenience or meet the views of the cultivator. When the late turnips are on the ground till April, and a dry spring occurs, there is often great difficulty in reducing the clods, and then the moisture is lost, and possibly the crop. A clod-crusher may in such a case easily save the whole of its cost in a single year. The variety of barley usually sown is Chevalier, and a kind, long known and cultivated in the Riding, denominated "country barley;" and between these two the whole district is occupied. The Annat at one time prevailed to a certain extent, and the "battledore," an old variety, is nearly extinct. The quantity of seed sown varies from 2½ to 3 bushels per acre, and if that is diminished below that amount, there is found to be a loss in the crop. The best time for sowing is considered from the 21st to the 30th of March, and it is remarkable that if the seeding is deferred a week later there is a loss of some 8 bushels per acre.

The Chevalier has a disposition to lodge, but grows a finer and bolder sample, and is generally preferred by the maltsters. The growing of this on the grey sands and most inferior land on the series, has placed it in their power to compete with the best soils, and happily on the former the lodging tendency is not generally so prevalent. There has been recently a disposition to be black-eared in the barley, but no remedy has been attempted excepting the change of seed, by purchasing it in Mark-lane, which is said to have a favourable tendency.

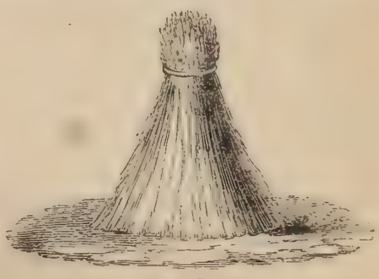
As soon as the barley is in the ground and once harrowed, the seeds are sown, consisting of quantities varying from 14 to 18 lbs. per acre, composed of white clover, trefoil, and Italian rye-grass, if for pasturage; and if for mowing, of red clover and the Italian rye-grass. These are usually sown by the hand, and lightly harrowed over. Soon after the barley is sown and before it has germinated, the roller is applied, and the surface made thoroughly

even and smooth. The harvesting is performed in the same mode as that of the wheat, except the sheaves are not hooded. The yield varies from 5 to 6 quarters per acre.

Following the barley are the

*Seeds.*—These grow rapidly after the barley is cut and carted, and are usually eaten but little in the autumn. In the following spring they are broken, if for pasture, by the sheep, about the middle or end of April, or sometimes allowed to be free till the month of May. On these they are allowed to roam at liberty; but within the last few years, instead of exactly putting into each field as many sheep as will be calculated to consume it, they place in one field nearly the entire stock of the farm, and eat the whole bare. In a few weeks they remove them into another unbroken field, and consume it in the same way, going in this manner over every field, and commencing when finished with the first field, which has sprung up sweet; and thus, instead of soiled and rejected and overgrown grasses, the whole are kept sweet, vigorous, and young, throughout the season. Others, however, "stint" or put into a field the stock it is finally intended to carry, and leave them to their fate to eat the food left for them or let it alone. By which mode soever the field is depastured, if the sheep have been employed in this process, it is in excellent condition for the growth of a corn crop, and even the annual weeds are, to a certain extent, germinated, and destroyed by the land resting for so long a period and being stocked with close-feeding animals.

In other cases where red clover is sown for mowing, it is seldom eaten in the spring, and is usually mown about the 30th of June, allowed to lie in swath for some three or four days, as the sun is scorching or otherwise; the clover which has fallen between the swaths raked up, and then the process of making is commenced; and we are not aware that it is carried on with so much perfection in any part of the kingdom as in the North Riding of Yorkshire. So soon as the surface is dry, a portion, about a yard in length, of the swath is taken, and the surface folded inwards, and the whole rolled into a kind of cone. A piece of rye-grass is pulled out of the top and tied round the head of the "ruckle," as it is called, and set in rows to admit it being easily carted. Thus while the sun and air thoroughly dry the whole mass, the rain, should it come, descends over the inclined surface of the cone, and as the large mass of leaves the clover possesses



Clover Ruckle.

renders it peculiarly liable to injury from the wet, this process is most valuable, and in few places is it secured in better condition. In a dry time it is carted directly from the "ruckles" to the stack; in a damp one they are sometimes to pull down before they are carted off, and made into "pikes," or small heaps, of from two to three cart-loads each; here the clover is allowed to ferment, and in a week or two put into the stack.

There are few districts where more difficulty has been experienced in obtaining red clover than has occurred here of late years. The value of the crop induced many cultivators to bear up against the clover-sickness, crop after crop, removing the red clover as far from its like as possible, by alternating with the small seeds; but this has been of no avail, and it is now found that the intervention of a crop of beans or tares is indispensable, if it is at all attempted. Beans are the greatest favourite, and these extending the period to eight years between the grasses enable the farmers to obtain good crops of red clover. The beans are usually sown in ridges and manured and well hand and horse-hoed, but they are found on those light soils to create a difficulty in keeping the land clean.

No other remedy for the clover-sickness has been discovered, and whatever may be its cause, neither lime nor any dressing yet attempted has been found to remedy the difficulty.

I have now followed the cropping and the mode of management through the whole of the course, and though this may be said to present the general aspect of the farming pursued, still many farmers deviate in some particulars from this rotation, and some very successful cultivators transpose the order of the crops. The Messrs. Outhwaite, of Bainesse, who obtained the prize for the best cultivated farm in the North Riding, or at least in a portion of it surrounding Richmond, within a radius of 25 miles, invariably sow the wheat after turnips, and the barley after seeds. Most of the wheat is spring corn, as a matter of course, and a considerable portion of the turnips is carted home, with a view to improve the manure, and hence a frequent dressing of some artificial fertiliser is given to the corn crops. The only disadvantage appears to be in the greater danger there is of getting in the corn as the season advances, and a premature frost has occasionally defeated, to a certain extent, their plans. It must, however, be confessed that there are few farms which will bear so close an inspection, and if the season is less favourable for securing the crops, the workmanship is such as to overcome, to a great extent, many of these difficulties.

Many thousands of acres on this series are considered so dry as not to need draining; still large portions of the district, principally grey sand, are almost inundated with land-springs.

Though the subsoil may be porous, there are sufficient intercepting strata to render it to a certain extent stagnant, and all attempts to cultivate this land in its undrained state are the most utter and irremediable failures.

There have been some instances of this description of land being improved and rendered fertile in this neighbourhood, which would do credit to any part of the kingdom, nor has the cost been so enormous as may be supposed.

Mr. Thomas Durham, of Ainderby, took a farm as a yearly tenant of Colonel Wyndham, which nearly ruined every previous occupier for thirty or forty successive years, for a rent of something like 7*s.* 6*d.* per acre. The produce at that time could not be more than five or six bushels per acre, and no tenant otherwise would take it. He immediately commenced a system of drainage. The soil was for the most part a blowing grey or yellow sand, but consolidated by powerful land-springs. He laid out drains so as to tap the sources of the springs, and as the subsoil was porous, he could ascertain their situation by holes cut the depth of the drains, for if his drains dried them, it was a proof that no intervening stratum of impervious matter occurred. The drains were some seven or eight feet deep, and did not occur at any regular intervals, one drain, with a few necessary branches, drying five or six acres around it, or even more. The tiles were about four inches bore, and the whole were of the horse-shoe kind and laid with flat bottoms. They were covered with straw to prevent the ingress of the silt, and effected wonders on the hungry sand. The expense was more in the cutting than in the tiles, and so powerfully did the abstraction of the water act on the running subsoil that in many cases the sides of the drain had to be kept asunder by planks until the tiles could be laid, and in many places the springs below the tiles boiled up so violently that it was impossible at first to obtain any sort of foundation for the soles. The cost, of course, varied, but we think from 3*l.* 10*s.* to 4*l.* per acre would cover it. Then, however, the work was only begun; the foundation was only laid.

By the application of bones he made the barren sand produce a fair crop of turnips. These he consumed upon the ground with sheep; sowed barley and seeds; eat the seeds with sheep, and then sowed turnips again, taking three green crops and consuming them with sheep for one grain crop, until the whole was rendered capable of growing wheat; and we think it no stretch of truth to state that it grows 4½ to 5 quarters of barley to the acre, and 23 to 25 bushels of wheat. So satisfactory is his tenure under so good a landlord, that it is better than a lease, and no advantage will ever be taken of the increased value of the pro-

perty by these judicious and well-arranged improvements. One great characteristic of the whole is, that he improved for pay and not for fancy. In cutting his drains, he sometimes encountered land-springs so powerful that no barricading of the sides nor any precautions within the drain could prevent the sides from falling in. To remedy this disadvantageous state of things, he carried on three parallel drains at the same time, and when this overwhelming rush of water came upon one drain, a tile was filled with hay or straw and placed perpendicularly in front of the last-placed tile, to prevent the ingress of sand, and it was left to flow on, and a parallel drain carried on until another similar spring broke out, and so many taps acting on the spring at the same time materially reduced the tendency to fill by abating the general power of the stream.

A remarkable instance in this district of the astonishing effects of improvements was on the Catton estate, purchased and effected by Mr. John Rob, of Thorpfield. In the year 1842 he commenced on 82 acres of grey sand, covered with a shallow stratum of peat, and growing little beyond moss and heather, and inundated by land-springs. Under the impression that it was totally unfit for any attempt at cultivation, some 35 years before, it had been planted with oaks, larch, and Scotch fir, at a cost of 6*l*. per acre; and to place the trees in a condition something approaching to safety, open ditches were cut so as to leave the trees in "lazy beds;" so wet and sterile, however, was the sand that some 32 acres of the whole had to be re-planted twice before they could be induced to exist, and even after so long a period several were not larger than walking-sticks.

After stubbing the trees the whole land was dug over some 9 or 10 inches deep, thus thoroughly incorporating the peat and the sand, at a cost of from 4*l*. to 6*l*. per acre, labour being cheap that winter, and in the same season drained with tiles and soles at from 3 feet 7 inches to 3 feet 10 inches deep, according to circumstances and capacity of fall. Occasionally the drains passed over patches or strata of clay, and in all cases the tiles were covered with heather and filled in with sand. At first attempts were made to fill in with the clay, but the water was not found to percolate, and the whole was thrown out again, and sand brought to fill in the drains. The cost of draining was 4*l*. 17*s*. per acre.

Part of the improved land was sown with oats in order to get the mass somewhat pulverised, as the roots and heath held the sand pretty firmly together; but the whole was nearly worthless and did not grow a crop equal to the seed sown. The remainder was ploughed and harrowed to break the lumps, and lime at the

rate of three chaldrons per acre was applied in the beginning of May—magnesian lime, which was worked in by Finlayson's drag, and then sown with turnips along with bones at the rate of 14 bushels per acre. The turnip crop succeeded, and was consumed on the land with sheep; after this oats were sown, and the produce was 9 quarters 6 bushels per acre. These nearly paid for the permanent improvements. A crop of maslin succeeded without any manure, which produced 32 bushels per acre, and sold for more than the *fee-simple* of the land before the improvements took place. The first-named portion was then made turnips, and the sheep while consuming them had $\frac{1}{4}$ lb. of linseed-cake each given to them per diem, and the crop of oats on this land was $10\frac{1}{2}$ quarters per acre.

The light sand, when the peat became decomposed, was of the lightest blowing character. Mr. R. luckily discovered in a high portion of the estate a stratum of red clay marl, soapy, rich, and unctuous, and this he applied very liberally at the rate of from 400 to 500 loads per acre. The soil was removed, the clay taken out, and then replaced, and no perceptible alteration took place; the effect has been astonishing, and the land is now capable of growing good crops of wheat.

### 2. *The Clay District.*

We now come to the flat extensive vale of Cleveland, nearly the whole of which is a cold tenacious clay, resting chiefly on the blue lias, and being covered by a somewhat flat stratum of diluvium, principally doubtless dissolved lias, and this tenacious, plastic, impervious body spreads over the whole district a degree of exhaustion, wetness, and sterility which gives it a peculiarly bleak and barren aspect, especially the lower portions, which are full of stagnant water. There are, it is true, many and honourable exceptions. Mr. Mauleverer, Mr. Maynard, Mr. Bates, Mr. Wilson, Mr. Wharton, Mr. Vansittart, Mr. Black have done much to convert this cold and unpropitious soil into a rich and productive loam. Mr. Mauleverer has transformed a comparatively desolate waste into a perfect model. Mr. Maynard, by the draining-plough and four horses, threw out a large portion of the soil, and then followed till the requisite depth was attained; and thus, as frequent drains are necessary, the cutting, which is a serious expense, was somewhat facilitated, and partly got over by a useful plough and strong horses. To overcome in some degree the tenacity of the soil Mr. Maynard used burnt clay very extensively, and has done much to set an example to the district.

Mr. Black and Mr. Wilson are careful and judicious cultivators, growing green crops very extensively, and do much to show

that the soil is not unimprovable, though there is great difficulty. But the systematic and permanent character of Mr. Wharton's improvements at Skelton is beyond all praise. No mechanical skill, no scientific appliance, no improved mode of cultivation which has stood the test of experience but he adopts, and his grateful tenantry are beginning to live and thrive around him, who before were the miserable occupants of a semi-neglected desert.

The vale of Cleveland, once abundant in grass, and famous for its cheese and horses, has witnessed its grazing grounds piecemeal converted into tillage land, cropped as long as it would grow a corn crop—little or no extraneous manure brought back to replace the loss—until lost in wet and adhesiveness; keeping little stock; making less and less manure; every third year a bare fallow, so that a few wet seasons once prevailing, the great mass of farms being totally undrained, there is nothing but starvation spread over nearly every parish. At one period lime was liberally used, and had beneficial effects, mechanical and otherwise; but this was disused, and since, the district has descended further and further in the scale of good cultivation. The improvements adopted may be classed under four heads—*Draining, Artificial manures, Green crops,* and *Stock feeding.* Various modes of draining have been tried, chiefly down each furrow, filling up with soil 20 to 25 inches deep, with horseshoe tiles without bottoms; stones occasionally used, and in some cases the mole-plough has been tried, and the drains are running successfully after an interval of 30 years. But the best instances of its success are upon the grass land, where it has been of very great benefit.

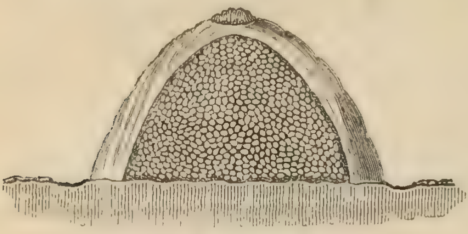
The artificial manures introduced into the district are principally rape-dust and guano, and when used for green crops, are found to lay the foundation of success in making future manure, and keeping stock wherewith to make a profit, and sustain the manurial resources of the land. The green crops are principally clover, soiled, or consumed on the land, and turnips occasionally; and linseed, boiled or scalded, and mixed with chaff; or oil-cake given to the holding stock in the straw-yards either to assist the turnips, or as a substitute for them, when, as is no uncommon case, they fail in a very wet or a very dry season. The turnips are all carted off the land, and sometimes tares are substituted in part for clover.

The old unimproved farmers adopt a course of cropping of 1 fallow, 2 wheat, 3 oats, alternating sometimes with 1 fallow, 2 wheat, 3 beans; some again a little advanced have, 1 fallow, 2 wheat, 3 clover—broken up for wheat.

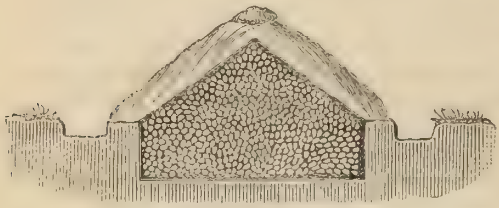
The matter of *open fallows* is as to whether they are to be near each other, and only grey or corn crops to intervene, or they are to be far removed. Hitherto the best cultivators have not been able to dispense with them entirely; and as we observed, the mass of farmers adapt their management to the cognomen of the soil "Two-crop and fallow."

The fallows are usually ploughed in the month of February or March, with three horses, some four or five inches deep, cross ploughed so as to lie in large clods. The sun and air permeate through these, and the weeds die for want of moisture, and so the hotter and drier the summer the better the fallow. The autumnal rains expand the contracted clay, and thus it crumbles into small pieces. The "lands," or spaces between the furrows, vary from six to seven yards wide, and slope gradually into the furrows, so that the water may descend—flow on to the ditches, and thus be carried off the land. The *wheat sowing* is a very critical time; if too wet, the sowing will be impeded, or possibly altogether prevented, so that after harvest there is a most complete season-watching. Two bushels or six pecks per acre is the maximum quantity of seed sown, and it is usually sown broadcast, in the seam made by the plough, in the crumbled mass immediately before the sowing. The crop is generally small, and is invariably shorn, high stubbles being left on the land. The sheaves are occasionally hooded. The mass of farmers apply no manure whatever to the wheat crop—the whole is reserved for the subsequent crop of oats or beans. It is too often little better than straw, and is carted out during the frost of winter to the wheat stubbles, and the whole ploughed in the month of February. The *oats* are sown in March, at the rate of 3½ bushels per acre. When not sown with oats, the manure is applied to the *beans;* but these are considered a risking crop, and being seldom ridged or horse-hoed, there is but little wonder. The young stock are too often fed on straw in the fold-yards, and on hay upon the grass in the spring; and some farmers go so far as to remove the whole of the manure from the tillage land and carry it to the grass. A more impoverishing system can hardly be conceived, when no extraneous matter is returned to the land. The samples of wheat are however extremely good, and weigh well; they are considered in London next in value after those of Essex, Kent, and Suffolk, and generally command a price little inferior; and even this may arise from the distance (it having to be conveyed by ship), rather than from any great deficiency in quality. The grain is full and plump—"bold," as it is provincially, and not inappropriately, called. The weight is very superior, being often as much as 64 lbs. per bushel, and Stockton-on-Tees is the port at which it is usually shipped.

*Mangold Wurzel* is but little cultivated, except by Mr. Vansittart; and *potatoes* are considered so great a scourge to the soil that they are little grown. They are invariably planted with unfermented or fresh dung, and when got up are stored "in pies" on the level surface. The difference in preservation between these roots in the clay district and the sand is remarkable. In both they are placed in conical heaps, with straw and soil covered over; while on the clay they are usually placed on the surface, and are found to preserve the best in such a position; while they are stored the safest on the light soil district by being pitted deep in the ground; in the one case they are placed above ground to prevent the access of wet, while in the latter they are placed deep, to prevent the access of air—both tending to defeat preservation, the one by promoting premature germination, the other decay.



Section of a Potato-pit on Clay Soils.



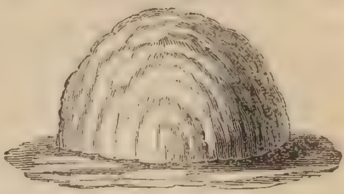
Section of a Potato Pit on Light Soils.

## 3. *The Grazing Valleys.*

The valleys of the mountain limestone district of Wensleydale, of Swaledale, and of Bishopdale—for the hills are wide expanses of bleak barren moorland—lying too high for cultivation, at least so far as present knowledge extends, have a climate considered too cold to admit of cultivation of the cereals, and nearly the whole is making so much in grass, that there is but little to tempt any parties to withdraw it from that mode of production. The valleys of the Ure and the Swale appear to have been worn down by these streams which have their origin at the extreme north-west of the Riding; and as the limestone is abraded, and is carried by the rills down to the bottom, this deep accumulation presents a soil richer perhaps than in any other part of the county, though less valuable than some in consequence of its being far removed from the traffic and population of Yorkshire. Nearer the hill tops the rock is more lightly

covered with soil and the grass of a poorer quality, but is nevertheless very valuable in producing cheese. On the lower and more productive portions cattle are grazed and fed for the markets of the West Riding of Yorkshire and Lancashire; pigs are fed on the milk after the cheese has been made: and thus the exports are fat cattle, sheep grazed on the more perpendicular uplands, bacon, lard, and cheese, richer perhaps than even the Derbyshire or Cheshire, but destitute of the peculiar flavour of the latter, and more mild generally than the former. The calves are partly reared in the valleys and partly sold off, and the cattle are purchased at the Falkirk and other trysts of the north. It is no uncommon thing for one beast to be fatted on an acre. The main duties of the dairy devolve upon the females of the house; and as there are no green crops, and no corn, the cattle have to depend through a long winter, usually severe, upon the hay exclusively; hence, the hay-time is principally the busy season, and a more catching and critical time, in this rainy district, it is hardly possible to conceive.

A small portion is usually mown, turned assiduously, and always placed in lap-cocks, *i. e.* raked into small heaps of the dimensions just capable of being taken up in the arms and then shaken, so as to present an even surface; it is folded round the arm, and so doubled, set down firmly on the ground, and there remains, until a promise of another favourable day, when they are thrown out and exposed to the sun again; and this is repeated until the whole is fit for "pike," or conical heaps, containing from half a ton to a ton. These, after undergoing an incipient sweating or fermentation, are combined in a stack and undergo another fermentation, and possess a grateful aroma peculiarly rich, and its nutritive character enables cattle to get fat upon it alone without any subsidiary food. The limestone is of the purest possible character, and it is extraordinary what powerful effects are produced by its application even upon those grass lands lying immediately upon it. The extraordinary phenomenon of coarse benty grasses giving way before rich and thick-set white clover, —even where no seed is sown—on its application to the land, is not easily accounted for, except on the hypothesis that the seeds are existing in the soil in a condition unfavourable to germination, and are stimulated by the application; but there is no doubt whatever of the fact.


Hay "Lap-Cock."

The only bar to productiveness in those rich valleys is the

presence of springs of water breaking out of fissures of the rock; these decompose the limestone, and favour aquatic grasses and mosses until a peaty superstratum is formed. These drained, with the stones which are everywhere abundant, and having some four to six tons of lime applied, a degree of alteration is made in the productions of the land which almost surpasses credibility. I made a valuation of the same land under exactly similar circumstances; but one part in its natural wet undrained state, another portion drained only, and the remaining part limed. It lay at the highest point of the valley, and we valued the land, in a state of nature, at 2*s.* 6*d.* per acre; the drained only at 5*s.*, and the drained and limed land at 20*s.* per acre.

From the nearness of the limestone to the surface, the shaken and horizontal character of the strata, and the presence of coals sufficient to burn it on the spot, it can be manufactured into lime for a price which, considering some beds contain as much as 98 and even 99 per cent. of carbonate of lime, is almost incredible; but there is no doubt whatever of its being obtainable on the spot at a cost of 3*s.* 6*d.* per ton. This is, however, under circumstances peculiarly favourable, and possibly 4*s.* might be a safer sum, but it has been burnt at a cost so little as 2*s.* 6*d.* per ton. We consider Wensleydale the most fertile valley in the Riding; but as no corn is grown the whole is brought from a distance, and hence Leyburn is one of the dearest markets in the Riding, and Malton the cheapest.

We give the analyses of the seven strata of limestone exposed in the valley:—

| —— | Carbonate of Lime. | Carbonate of Magnesia. | Alumina, &c. | Silica. |
|---|---|---|---|---|
| Harmby | 94·30 | 0·18 | 3·22 | 2·30 |
| 12-fathom bed | 98·70 | 0·25 | 0·80 | 0·25 |
| Undersett | 96 | 0·18 | 2·32 | 1·50 |
| Ten-fathom bed | 96·30 | 0·15 | 1·35 | 2·20 |
| Five-fathom bed | 99·10 | 0·20 | 0·50 | 0·20 |
| Fifth stratum | 99·40 | 0·15 | 0·30 | 0·15 |
| Sixth stratum | 98·35 | 0·15 | 1·30 | 0·20 |
| Seventh stratum | 99·40 | 0·25 | 0·25 | 0·10 |

Compared with some other limestone of the county used in agriculture, it is much superior, viz.:—

| —— | Carbonate of Lime. | Carbonate of Magnesia. | Alumina, &c. | Silica. |
|---|---|---|---|---|
| Knottingley lime | 88·50 | 9·40 | 0·95 | 1·15 |
| Ripon | 54·60 | 43·95 | 0·85 | 0·60 |
| Kepwick | 86·00 | 6·20 | 0·03 | 7·77 |

### 4. *The Mixed District.*

We have now the difficulty of describing the farming of a variety of soils, altitudes, and situations, scattered over the moorlands of the oolitic series, and the valleys traversing them, some, in a degree greater or lesser, covered with diluvium of a mixed character, and each division and subdivision being modified so as to present no great distinctive outline. *In general,* we may say, that the oolite of the East and the magnesian limestone of the South-West are under the four-course or convertible system, with more or less modifications; the valleys of the lias partake of the strong Cleveland soil, while the vale of the Derwent from its source, the vales of the Rye and the Esk are more or less of a peaty character, and grow hardly any grain but oats, while the high elevation of the eastern moorlands leaves their valleys of the same character. The general course pursued is 1, turnips; 2, oats; 3, 4, seeds (kept two years in pasture); 5, oats. Some of these regions are so very exposed, and the climate above and the nearness of the water below render, in some years, the securing of the crops very difficult. The eastern moorlands lie a considerable height above the level of the sea: Black Hamilton 1246 feet; Brotton Head, near Stokesley, 1485; Roseberry Topping, 1022; and the quantity of uncultivated hills and moors rising from 1000 to 2000 feet is said to amount to some 400,000 acres. The turnips are chiefly consumed by sheep on the land, and the seeds eaten often by ewes from the lowlands in summer when the lambs are taken from them. The coolness and pasturage are favourable, and they usually return in September or October in very excellent condition to be ready to put to the ram.

Mr. Mauleverer has shown a specimen of what may be done in rendering productive even this moorland district, with all the disadvantages of soil and climate, in his little model 'Ladye Chapel Farm,' where the sheep are being fed on what used to be the haunt of the wild mouse and the mole, and the luxuriant oats are waving before the wind that used to whistle through the whins and the heather.

There are many spots, however, where science and skill have rendered various portions of this miscellaneous district near Kirby Moorside and Helmsley highly productive; the estates of the Lord Feversham are well cultivated, on a strict alternate rotation, and, if it has a fault, it is in adhering somewhat pertinaciously to the sowing of clover, and to one uniform adherence to the Norfolk system In the lowland portion, embracing the south-eastern part of the Riding, there are not a few instances of excellent farming: the farms of Mr. Wiley, of Brandsby, Mr.

Linton, of Sheriff Hutton, Colonel Croft, of Stillington, and many of the superior farmers set a noble example of thorough-draining, high cultivation, large and weedless crops, and great numbers of excellent sheep, their farming verging on the well-understood and well-acknowledged system of "crop green and crop grey."

*Stock.*

*Cattle.*—The "Yorkshire cow," so celebrated, and more prized when milking and dairy qualities were more esteemed and more admired than early maturity or disposition to feed, is losing caste. As the dairies and grass began to disappear, the distinctive breed has given way, and the celebrated breed of the banks of the Tees, the *short horns*, are spreading with more or less purity, and a greater or lesser degree of alloy—spread by the excellent landlords, who, patronizing breeding themselves by purchasing the stock of the first and most judicious breeders, have allowed their tenants the free use of these superior animals; and hence the short-horns have spread so far that it is no unusual thing to find animals of twelve to eighteen months old sold fat to the butcher. To enumerate the breeders of the North Riding were therefore to name the greater part of the landed gentry and aristocracy; but even the professional breeders are numerous, and stand so high that it were invidious to name them except alphabetically. The most distinguished are Mr. Bates, of Kirklevington; Mr. Beetham, of Harlsey; Mr. J. Booth, of Killerby; Mr. R. Booth, of Warlaby; Mr. J. M. Hopper, of Newham; Mr. W. Linton, of Sheriff Hutton; Mr. Maynard, of Harlsey; Mr. S. Wiley, of Bransby, &c., &c.; and there are not perhaps in the three kingdoms parties who can equal them in the same area for purity, quality, symmetry, and all the characteristics of short-horns.

*Horses.*—The Cleveland, as a pure breed, is losing something of its distinctiveness. It is running into a proverb that a Cleveland horse is too stiff for a hunter and too light for a coacher, but there are still remnants of the breed, though less carefully kept distinctive than may be wished by advocates of purity. Still the contour of the farm horses of Cleveland has the lightness and hardiness and steadiness of the breed in outline; and it is singular that while the lighter soils have horses more calculated for drays, the strong-land farmer has the compact and smaller, but comparatively more powerful animal.

*Sheep.*—Few better specimens of excellent sheep exist than in this Riding. The long-woolled, or improved Leicester, are the general favourites, and bone, wool, and mutton seem to be rather the desiderata than mutton alone. The favourite sheep on the turnip-soils is that which weighs when fat some 28 to 30 lbs.

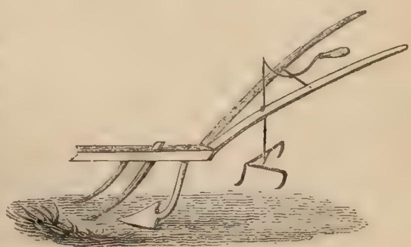
per quarter, and nearly the whole are fed in winter on turnips, and kept until they are two years old; some attempts at selling them at thirteen or fourteen months old have been made, and in some cases with profit to the owners, but the system is far from being general. Amongst the principal ram breeders are Mr. Boston, Mr. Carter, Mr. Kendall, Mr. R. Outhwaite, Mr. Sonley, and Mr. Wiley, and very fine specimens of sheep are bred by all these gentlemen and many others. The pure Leicesters have also many advocates in the Riding.

Some farmers graze and winter the Northumberland sheep and sell them early; but so fatal has been the epidemic of late years on all travelling animals, and the injury inflicted on the farmers by introducing disease, that the practice seems to be losing ground.

*Pigs.*—The long-eared and large breed are rapidly falling into disuse; they are still preferred in the Dales, where they are kept long on hand; but the small breed are chiefly in favour and are found to be on the whole the most profitable, being easily fed, and producing a greater return for the food given.

### *Implements.*

The Yorkshire Agricultural Society has done much in introducing good implements, its patient trials have taught both farmers and implement-makers a lesson, and the names of Busby, Scurrah, Teasdale, and others have sprung up with it, and may be classed amongst the highest of the many excellent plough-makers, and their implements are spreading through the Riding. The old wooden ploughs—which are made upon no mechanical principle, are good or bad as the maker may have made a lucky hit or not, and no two of which are entirely alike—are a disgrace to the Riding. Barratt's, Busby's, Ransome's, Exall's, and many others, are gaining ground every day; Crosskill's clod-roller is appreciated by the best farmers, as an invaluable implement. Finlayson's drag is all but general in the light soils; and Ducie's cultivator, Busby's and Barker's stubble-parers, and a series of other scarifiers are brought into use by the clearing of the stubbles in autumn: having the facilities of clearing themselves of rubbish, and adaptation to go deep enough to get below the root-weeds. Scufflers, made by Mr. Scurrah, are very valuable implements, and by a small lever attached to the



Scuffler with Lever Harrow.

rake behind drag out all the small weeds, and leave them at the surface of the land. One-horse carts are in much favour, and the large and heavy waggon is fast disappearing throughout the whole Riding. Richmond's straw-cutter, Clyburn's crusher, Charnock's tile-machine, and Gardner's turnip-cutter, are amongst other favourite implements. Several apparatus, for boiling linseed by steam, and one or two agricultural steam-engines exist in the Riding, and a growing disposition appears to be manifested to use the compound in preference to cake.

### *Tenancy.*

The tenants are principally from year to year, the farms small, and a somewhat considerable portion of the Riding is in the hands of the yeomanry. There is a dislike to leases generally, and I have known instances where tenants have refused to take a farm because they were to be bound to it by an imperative lease. Some land-owners are beginning to bind themselves to pay their tenants for unexhausted improvements: amongst the foremost of these is J. T. Wharton, Esq., of Skelton Castle, who adopts the Lincolnshire practice in his agreements with the tenants.

### *Labourers.*

This class is a very healthy, hardy, and faithful race. Incendiarism is a very rare vice; the wages are 11*s*. and 12*s*. in winter and spring, and in hay-time and harvest as much as 15*s*. and 18*s*. per week, with meat and allowance; drainers have 15*s*. per week in the winter months: task-work is very common; turnip-hoeing 7*s*. per acre; corn-cutting 8*s*. per acre, and women have 9*d*. per day of eight hours, and 1*s*. 6*d*. and 2*s*. in harvest for nine hours. The dwellings and cottages of the labourers are somewhat small, but they are rapidly improving, and the allotment system is very prevalent from one end of the Riding to the other.

### *Tanks for Liquid Manure.*

These are not so common as might have been expected, and in not a few instances are the rich soluble parts of the manure seen dribbling away by some covered drain or some open ditch. There are, however, some instances where tanks have been adopted, and their utility and application are but ill understood. It is found that when applied directly to grass, the liquid does not answer the purpose, unless in quantities to irrigate the land; the rains in winter wash it away, the drought in summer tends to evaporate it; so that to apply it economically, it is desirable to saturate with it from time to time some decomposed vegetable matter, or some compost-heap previously prepared, and this,

saturated time after time, is found to be a most valuable manure.

The instances where the tanks are the most useful are where the whole of the eaves are spouted, and no excess of water is permitted to saturate the manure. They are of brick, sunk at a low level, and covered and lined with a coat of Roman cement, and of a capacity of a cubic yard to each ten acres on the farm.

### *Improvements required.*

I have glanced at the *improvements* in order, as we have passed over the various districts; and it will be perceived that though portions of the Riding are farmed so highly that it would be difficult to suggest any very extensive improvements in the mode of cultivation adopted, still there are large districts where scarcely a beginning has been made. The whole valley of the Rye and the Derwent is about being drained by removing the mill-dams at Malton, and thus obtaining fall; and this pass being lowered it is hardly conceivable what results in improved value of the land in these valleys may be attained. It is surprising that a tract like Pillmoor, on the side of the York and Newcastle Railway, should remain in its present desolate state, not worth 1*s.* per acre, when, by an outlay of some 10*l.* or 12*l.* per acre, the whole might be made worth a rental of 20*s.* to 25*s.*

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## XXVII.—*On a Drill for distributing Superphosphate in a Liquid State.* By Thomas Chandler.

*To Mr. Pusey.*

Sir,—Agreeably to your request, I herewith forward you the result of my experiments in the culture of turnips with superphosphate of lime in solution, in comparison with the same manure in compost.

It might have carried more weight with it had it come from a less interested party, but still I trust that, from being known personally to some readers of the Journal, and from many leading agriculturists having inspected those experiments, they will be relied upon as unprejudiced facts.

I also send the opinions of other farmers who have tried the machine, which I should have mentioned first but that my own experience has extended over a longer period, and has been formed under a greater variety of soils and circumstances.

My attention was first called to the subject by reading the very

excellent paper on dissolved bones, by Mr. Hannam, in the fifth volume of the Journal, which induced me to try the effect of it on a small scale, by letting the liquid run from a box through holes at intervals of 18 inches, and sowing the seed immediately after with the broadcast seed-machine. The turnips were visible in the rows where the liquid had fallen three days before those between the rows, and were fit to hoe ten days before them; as the season advanced, the superiority of those plants in the drills was still more apparent, and continued so in the same proportion to the time they were fed (September, 1845). The quantity of manure used in this instance was only half a bushel of dissolved bones diluted with tank-liquor.

Encouraged by this, I was most anxious to procure a drill that could be used on a larger scale, and made diligent search and inquiry for one, but without success; eventually I prevailed on the Messrs. Reeves, of Bratton, to make one under my directions on the principle of the dredging-machine, which I have found to answer well, and by which the following experiments were made:—

No. 1.

The soil a flinty loam, of good quality, the whole equally manured with farm-yard manure, the land well pulverized, and sufficiently moist to vegetate the seed. Waited till July 14th for rain.

*July* 15*th*, 1846.

Lot 1.—$5\frac{3}{4}$ acres. Drilled $1\frac{1}{2}$ bushels of bones dissolved per acre, to which was added 500 gallons of tank-water very much diluted.

Lot 2.—The seed drilled on a quarter of an acre without any extra manure.

Lot 3.—2 acres. Drilled $1\frac{1}{2}$ bushels of bones dissolved per acre, and 500 gallons of spring water.

*Weight on the* 24*th of December*, 1846.

Lot 1.—15 tons 6 cwt. per acre.
Lot 2.— 6 ,, 4 ,, ,,
Lot 3.—14 ,, 0 ,, ,,

In the same year I applied a double quantity of water from the river to that stated above, with the same quantity of bone. There was no perceptible difference.

1847, No. 1.

Drilled a day, with $1\frac{1}{2}$ bushels of bones in solution, land previously manured with the fold. One coulter of the drill (a five-row one) deposited the seed without the extra manure. The plants where no liquid was put were entirely destroyed by fly; the other rows recovered and produced a good crop of turnips.

No. 2.

A very poor piece of land, containing 18 acres, valued by an eminent land-surveyor at 7*s*. per acre; previous crop, oats.

*May* 18*th*.

Lot 1.—10 acres. Drilled with 1 sack of dissolved bones per acre, diluted with 400 gallons of water from a sheep-pond.

Lot 2.—8 acres. Drilled with 1 sack of bones dissolved, mixed with four one-horse cart-loads per acre of a compost of night-soil, the sweepings of the stable, and ashes.

| | | | | |
|---|---|---|---|---|
| Lot 1 came first to hoe, and produced | 16 | tons | 2 | cwt. |
| Lot 2 nearly a week later to hoe | 13 | ,, | 4 | ,, |

No. 3.

Soil a flinty loam; previous crop vetches, mown for hay. Manured with farm-yard manure. Drilled, July 3rd, 7 acres, with 1½ cwt. of superphosphate of lime in solution, with 300 gallons of tank-water per acre.

Weighed January 27th, 1848. Produce, 13 tons 7 cwt. per acre. The drill was purposely allowed to go half the length of the furlong without any liquid. On this part there was not 5 cwt. per acre. The fly carried them off.

As turnip husbandry is the most approved method of enriching the soil, and, consequently, of increasing the production of corn, and as it is now carried on to so great an extent, any system that will have the effect of reducing the items of expenditure which come under this head will, I am sure, not go unnoticed by the practical agriculturist.

After the successful trials during three years (and the appearance of the turnips this year where it has been tried in the same way, notwithstanding that the wet season has assisted the compost, is greatly in favour of the liquid), I am so satisfied of the economy of applying soluble manure in a liquid form, that I have this season put in the whole of my roots, including the mangolds —together 140 acres—in this way, the cost of which for artificial manures will not exceed 10*s*. per acre.

It will be necessary, in order to explain how so small a quantity has been applied, to state the system I adopt in growing roots.

My farm consists of bottom, hill, and *bake* land, which I will describe separately. The "bottom" land is sown with wheat every other year, and a green crop between, which is one-eighth rye, one-eighth hop-clover, and one fourth vetches, the remaining part mangold, beans, and clover. The rye is fed twice. The sheep the last time it is fed lie in a fold on it by night, while in

the meadows; it is then pot-dunged, and drilled with 1 cwt. of superphosphate for swedes. The hop-clover is consumed after the sheep have finished the meadows, and served as the preceding piece for swedes; and also the vetch-ground, with the addition of ½ cwt. of superphosphate to the foregoing quantity.

The "hill" I sow, contrary to the most favourite notions of husbandry, with two white-straw crops in succession: the first wheat, the next barley, a moiety of which is sown with grasses; the greater part of the remainder of the field is afterwards sown with vetches, the other part with rye. The following spring the rye is fed and afterwards drilled with 2 cwt. of superphosphate for swedes; the vetches are also fed on the land, to which 1 cwt. of superphosphate is applied for rape and turnips for spring feed. The next year the sheep remain on the land while feeding the swedes and rape and turnips; it is then pot-dunged and sowed with white mustard, which gives a little feed when keep is short; it is then ploughed once and sown with turnips for fall (or autumn) feed, for which ½ cwt. of superphosphate is used. In the same field, after the old ley has been fed, it is prepared with farm-yard manure (carted to the field in the winter) and folded, and treated in the same way as the turnip part of the field.

The "bake" is divided into five fields, one of which is always down to sainfoin; of the other four, one is sown with wheat, half of which is sown with broad clover; next, half oats after wheat, half broad clover. Third year, half rye after oats, half oats after clover; the rye fed in the spring, and drilled with 2 cwt. of superphosphate for swedes. Fourth year, the manure of the swedes left when fed early in the spring of the year, pot-dunged, and drilled with vetches—the early winter variety I prefer—as fast as fed off; and in the latter part of March rape, drilled in the vetches, either across or between the drills, ½ cwt. of superphosphate per acre; the oats stubble sown with rye, pot-dunged, and folded, and 1 cwt. of superphosphate for fall turnips. All the manure from the fall-feed is left where made, in preparation for wheat.

I have somewhat digressed from my original purpose to show that 2 cwt. of superphosphate is an ample dressing to procure a *first crop* of swedes, although the land has been considerably exhausted by the white crops; and by leaving the manure as before described a very small quantity of artificial manure is sufficient to protect the plant from fly and other enemies in its early stages, and ultimately to produce a great quantity of feed.

Since I have adopted this mode I have very considerably increased the feed of the farm; and it may be seen by the foregoing statement that there is but little naked fallow for turnips.

I would remark that on the hill and bake land I make it a point to select the most couchy parts for *vetches;* after feeding them there is time for cleaning the land preparatory for rye; it is generally hot and dry at this season of the year, and the ground cannot be made too light for rye.

As an excuse for sowing the two white-straw crops in succession, I get *four* green crops on some portion of the land in the other two years; and by leaving the manure where the food is consumed the sheep are saved much travelling, and the land is gradually recovered to produce a heavy wheat-crop. By this system the land will be in a sufficiently high state of cultivation to carry barley with enough straw without further help, and the quality of the barley will be much better than after turnips, especially where sheep are fed on corn or cake when consuming the turnips.

There are four very important points gained by this machine over the compost drills, to which the patentee, in justice to himself, desires particular attention, viz.:—economy in the manure (see extracts below), the more even distribution of it, the greater expedition in its delivery, and the certainty of obtaining a plant.

The apparent difficulty of supplying the drill with liquid has, after many unsuccessful attempts, been entirely overcome by the following simple method:—

A common oil-pipe, which may be purchased for 10*s*., should be placed in a one-horse cart, on two blocks of wood fitted into the bottom of it, hollowed on the top sides for the cask to rest on: it should have a large bung-hole to allow it to discharge quickly, but instead of a plug a tin pipe should be attached to the barrel with leather to form a joint, so that the nozzle of the tube may be turned up to the top of the cask and be fastened there with a strap.

A small tub will be required in the field, at the end of the furlong, into which the superphosphate should be put and diluted with 20 or 30 gallons of water, and well stirred till properly mixed, which will be in a few minutes. The drill should then be set in its work, the water-barrel be brought alongside of it, and enough water put in to go a turn or bout; the attendant should at the same time take a bucket of the *mixture* from the tub and pour it into the drill; he can then proceed with the drilling immediately. The same *quantity* of *mixture* should be applied in all cases; the *quality* will be of course improved in proportion to the superphosphate added.

Three water-barrels, two on the road and one filling *(which may be accomplished with two horses)*, will convey sufficient liquid for a one-horse drill to put in five acres per day, at a distance

of a mile from the tank or river; and in the same proportion with the larger drills.

The merits of this implement will be more clearly explained by stating that dissolved bones (superphosphate of lime), or any soluble manure, are more evenly distributed in liquid than in compost; inasmuch as the difficulty of mixing properly the superphosphate in a sufficiently friable state for drilling is entirely superseded by the revolution of the cups keeping the liquid in a constant state of motion from the bottom of the drill, thereby giving to each plant an equal share of the manure.

It is an admitted fact that vegetables cannot take up as food anything solid; therefore the advantage of liquid manure must be apparent to every one.

The various enemies to which the turnip is subject in its earlier stages are, by this system, in a great measure defeated, the manure being so regularly deposited in the drills, that immediately the seed germinates it finds its food so congenial to its growth that it is soon placed in safety.

The drill is very simple in its construction, and may be made to any size. Of the two sizes that have been found most convenient, that for one horse is 4½ feet wide, which is best adapted for the ridge system, depositing two rows at 27 inches (this has been highly approved of for drilling mangolds); it can also be worked on the flat at the same distance, or three rows at 18 inches. The other is 6 feet wide, the coulters of which may be varied to five rows at 14 inches, four at 18, four at 20, three at 24, or seven rows for corn at 9 inches, with liquid manure, or ten rows of corn without manure, and for spreading liquid broadcast.

The liquid-manure box can be removed, and the drill worked as a common corn-drill, when manure is not required.

I remain, Sir, yours faithfully,

Th. Chandler.

*Stockton, Heytesbury, September* 23, 1848.

P.S.—The following extracts from the former numbers of this Journal will prove the advantages of this system of applying dissolved bones:—

## *Duke of Richmond's Experiment.*

### No. 1.

Lot 1—Manured with 14 yards of Farm-yard Dung and 8 bushels of Bone-dust.
2— ,, with 315 lbs. of Guano.
3— ,, with 16 bushels of Bone-dust.
4— ,, with 2 bushels of Bone-dust dissolved in 83 lbs. of Sulphuric Acid, previously diluted with 12 gallons of Water. 388 gallons of Water were added to it. The mixture was then applied to the drills in a liquid state, by means of a Water-cart.
5— ,, with 8 bushels of Bone-dust, mixed with 83 lbs. of Sulphuric Acid, previously diluted with 12 gallons of Water. This mixture, nearly in a dry state, was then sown by the hand along the drills.

| Lots | Cost of Manure. | | | Weight of Turnips. | | Value of Turnips. | | | Produce of Barley. | | | Weight per Bushel. | Value of Barley. | | | Total Value of Produce. | | | Value, after deducting Cost of Manure. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £. | s. | d. | Tons. | Cwts | £. | s. | d. | Qrs. | Bus. | Pk. | lbs. | £. | s. | d. | £. | s. | d. | £. | s. | d. |
| 1 | 3 | 0 | 0 | 12 | 0 | 3 | 0 | 0 | 4 | 1 | 3 | 56 | 5 | 18 | 1¼ | 8 | 18 | 1¼ | 5 | 18 | 1¼ |
| 2 | 1 | 17 | 4 | 11 | 4 | 2 | 16 | 0 | 3 | 5 | 1¼ | 55 | 4 | 19 | 1¼ | 7 | 15 | 1¼ | 5 | 17 | 9¼ |
| 3 | 1 | 16 | 0 | 11 | 0 | 2 | 15 | 0 | 3 | 7 | 1¼ | 55 | 5 | 5 | 11 | 8 | 0 | 11 | 6 | 4 | 11 |
| 4 | 0 | 11 | 6 | 12 | 4 | 3 | 1 | 0 | 3 | 4 | 3 | 56 | 5 | 0 | 7¼ | 8 | 1 | 7¼ | 7 | 10 | 1¼ |
| 5 | 1 | 5 | 0 | 11 | 0 | 2 | 15 | 0 | 3 | 6 | 2 | 56 | 5 | 6 | 9 | 8 | 1 | 9 | 6 | 16 | 9 |

## *Mr. Williams's Experiment.*

| | Manures and Quantity | | Application. | Produce per Acre. | | | Cost per Scotch Acre. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tons | Cwts. | lbs. | £. | s. | d. |
| 1842. | Bones . . . | 20 bushels . | Drilled . . . . . . . . | 12 | 4 | 3 | 3 | 3 | 0 |
| | Bones . . . .<br>Sulphuric Acid<br>Water . . . | 4 bushels<br>16 lbs.<br>224 lbs. | In 6,400 lbs. or 640 gallons of Water, in furrow. . . | 17 | 4 | 5 | 1 | 8 | 6 |
| | Bones . . .<br>Sulphuric Acid<br>Water . . . | 20 bushels<br>76 lbs.<br>126 lbs. | From the remarks below, I conclude that this lot was Bones sprinkled with Acid. —T. C. . . . . . . | 13 | 0 | 52 | 3 | 12 | 6 |

*Peculiarities:*—The difference between the applications and the bone-dust applied in the usual way "was most marked;" the sulphuric solution brought the turnips to the hoe ten days earlier than the bones alone, and four days before the bones *sprinkled with acid.*

## *Mr. Gedde's Experiment.*

| | Manures and Quantity. | | Application. | Produce per Acre. | | | Cost per Scotch Acre. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tons | Cwts. | lbs | £. | s. | d. |
| 1842. | Manure . . .<br>Bones . . . . | 15 loads<br>15 bushels | . . | 13 | 19 | 21 | 3 | 12 | 6 |
| | Bone-dust . . .<br>Acid . . . .<br>Water . . . | 1 bushel<br>67½ lbs.<br>201¼ lbs. | In 6,600 lbs. or 660 gallons of Water . . . . . . . . | 13 | 10 | 21 | 0 | 17 | 6 |
| | Bones . . . . | 12 bushels. | Dibbled . . . . . . . . | 11 | 9 | 21 | 1 | 18 | 0 |

## *Duke of Richmond's Experiment.*

### No. 2.

| | Manures and Quantity. | Application. | Produce per Acre. | Cost per Acre. |
|---|---|---|---|---|
| | | | Tons Cwts. lbs. | £. s. d. |
| 1843. | Bones . . . 16 bushels. | . . | 11 0 0 | 1 16 0 |
| | Bones . . . 2 bushels<br>Sulphuric Acid . 83 lbs. | With 400 gallons of Water . | 12 4 0 | 0 11 6 |
| | Bones . . . 8 bushels<br>Sulphuric Acid . 83 lbs. | Acid spread over Bones and sown . . . . . . . . | 11 0 0 | 1 5 0 |

## *Mr. Hannam's Experiment.*

| | Manures and Quantity. | Application. | Produce per Acre. | Cost per Acre. |
|---|---|---|---|---|
| | | | Tons Cwts. lbs. | £. s. d. |
| 1843. | Bone-dust . . 16 bushels. | Drilled with Seed . . . . | 15 3 4 | 1 13 0 |
| Soil, very thin limestone, and poor in condition. | Bone-dust . . 8 bushels<br>Sulphuric Acid . 168 lbs.<br>Water . . . 604 lbs. | Drilled with Water equal to 50 times the weight of the Acid, applied in the furrow, ridge ploughed up, and then seed-drilled . . . . . | 17 7 1 | 1 15 0 |
| | Bone-dust . . 8 bushels<br>Muriatic Acid . 168 lbs.<br>Water . . . 604 lbs. | Diluted and applied as above | 17 7 1 | 1 19 6 |
| | Bone-dust . . 8 bushels burnt to half its original weight . . . . . . .<br>Sulphuric Acid . 84 lbs.<br>Water . . . 252 lbs. | Ditto ditto | 13 7 6 | 1 6 0 |
| | No Manure . . . . . . . | . . | 7 0 6 | . . |

The following are a few, amongst many Testimonials, from gentlemen who have worked the Drill upon their own farms:—

" *Stourhead, Nov. 22nd*, 1847.

" Dear Sir,—According to my promise, I have to-day drawn four drills [at 27 inches] of turnips, two of them side by side, the other two in different parts of the field: the weight of the two drills with the liquid manure was 7 cwt. 16 lbs.; the other two drills, which were manured with a compost of horse-dung, charcoal, ashes, and sweepings from the piggeries, weighed 1 cwt. 2 qrs. 12 lbs., showing that the one bushel of dissolved bones, diluted with the overflowing of the manure-tank, has given 620 lbs. above the compost, which was applied after the rate of 3½ qrs. per acre.

" Sir Hugh Hoare desires me to order two drills, one for this farm, and one for Bucks.

" I am, dear Sir, yours truly,

" C. Cardwell,

" Mr. T. Chandler, Stockton." " Farm Agent to Sir Hugh Hoare."

"*Codford, Nov.* 24*th*, 1847.

"SIR,—In reply to your inquiry as to my opinion of the Liquid Manure Drill, and the system of putting in turnips with dissolved bones diluted, I think it the greatest advance in agricultural improvement that has yet taken place. The difficulty I had anticipated in applying the liquid was entirely removed from my mind when I saw your drill at work; I am now perfectly satisfied that there is not only a vast saving of manure, but also in the time occupied in drilling. We drilled five acres of rape in eight hours with your one-horse drill; and from its being our first attempt I have no doubt with a little more practice we shall get on faster. The five acres of rape were put in July 30th, with 8 cwt. superphosphate of lime. An adjoining part of the field, under the same tillage, but sown a week previously, to which we had applied 4 bushels of bone-dust and 2 bushels of dissolved bone, with 50 bushels of ashes per acre (notwithstanding the expense was twice as much), is not so good by considerable as that portion manured with the liquid.

"I have in my possession an excellent Compost Drill by Hornsby, but so satisfied am I with the use of your Liquid Manure Drill, that I shall feel obliged by your sending me one before the commencement of the next season.

"Yours truly,

"To Mr. Thomas Chandler." "WM. BENNETT."

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"*Fisherton-de-la-Mere, Nov.* 30*th*, 1847.

"SIR,—The turnips that were put in with your Liquid Manure Drill (although under very adverse circumstances, it being very wet), with one sack of dissolved bones per acre, have very far excelled any that I have on my farm beside, even where we had applied two sacks of bone-dust, and as many ashes as could be made to go through the drill.

"I was surprised at the expeditious manner that the drill performed its work, as were also the company in general who were present to witness the ploughing-match of the Wiltshire Society, held on my farm on that day (June 17th).

"I am, Sir, yours truly,

"To Mr. Thomas Chandler." "JOHN FILL HART."

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"*Kilmington, Nov.* 27*th*, 1847.

"MY DEAR SIR,—In answer to yours of the 24th instant, I beg to say I have been constantly watching and comparing the growth of my turnips put in by your Liquid Manure Drill with *two bushels of dissolved bones and water* per acre, and those put in the same day, side by side, with just *double the quantity of dissolved bones and ashes*, and am bound to say that, from their first appearance to the present time, the superiority of your drilling has been most apparent. I think by your system there must be at all times a greater certainty of a crop, from the rapid growth of the plant in its earliest stages; and as the expense of supplying water, &c., is not greater than that of supplying ashes in the ordinary way, and as your drill is capable of putting in quite as many acres per day as any other drill of the same breadth, I not only consider it most valuable, but think it will be found almost indispensable.

"I am, dear Sir, yours most truly,

To Mr. Thomas Chandler." "JOS. LUSH."

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*Heele, Woodford, Salisbury, Dec.* 24*th*, 1847.

"MY DEAR SIR,—I have much pleasure in informing you, that, although very late (and after vetches too), the turnips I put in with your "Liquid

Manure Drill" have made wonderful growth, and I was much surprised and pleased with the very regular manner the machine deposited the manure in a state of solution; and I hope, next season, to avail myself of your simple though valuable drill to put in my early turnips. My farm being extremely hilly, I thought the labour of drawing the water would be a very expensive affair, but it did not cost more than carting the quantity of ashes I generally drill with *dry* bones or guano.

"I remain, my dear Sir, yours sincerely,

"To Mr. Thomas Chandler." "JAMES RAWLENCE."

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Prices of the Patent Liquid Manure Drills, as supplied at their manufactory, Bratton, Westbury, Wilts, by Messrs. Reeves, Agricultural Implement Manufacturers.

| | £. | s. | d. |
|---|---|---|---|
| No. 1.—A 6-foot drill for drilling liquid manure with seven rows of corn, or five rows of turnips, or for distributing the liquid manure broadcast; forming also a complete ten-row corn-drill without manure . . . | 42 | 10 | 0 |
| Extra if delivered at Southampton, London, or Bristol, 1*l.* 10*s.* | | | |
| No. 2.—A 6-foot drill for drilling five rows of turnips with liquid manure, or ten rows of corn without liquid manure, or for distributing liquid manure broadcast . . . . . . . . . | 39 | 0 | 0 |
| Extra for carriage as above, 1*l.* 10*s.* | | | |
| No. 3.—A 6-foot drill for drilling five rows of turnips with liquid manure, or for distributing liquid manure broadcast . . . . . . . . | 27 | 10 | 0 |
| Extra for carriage as above, 1*l.* 10*s.* | | | |
| No. 4.—A 4½-foot drill for drilling five rows of corn with liquid manure, or three rows of turnips with liquid manure, or for distributing liquid manure broadcast . . | 26 | 0 | 0 |
| Extra for carriage as above, 1*l.* | | | |
| No. 5.—A 4½-foot drill for drilling three rows of turnips on the flat, or two ditto on the ridge, with liquid manure, or for distributing liquid manure broadcast . . | 22 | 0 | 0 |
| Extra for carriage as above, 1*l.* | | | |

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## XXVIII.—*On the Putrefaction of Bones.* By PH. PUSEY.

HAVING formerly mentioned the practice of decomposing bones in mixture with ashes, and last year proved that the same result arises from their mixture with sand or ashes, I wish now to add a few words on this subject, particularly as some who have tried the operation have failed. This can be no matter of surprise where, as in one instance, the bones were laid up, I believe dry, in a heap, and rough earth shovelled over them. I have this year mixed bones with peat-ashes, coal-ashes, sand, mould, and sawdust. The fermentation was equal where the size of the heap was the same; but a small heap, unless carefully enclosed and covered, will not decompose so thoroughly as a large one, perhaps not even then. Whatever the substance employed, it should be

in a free pulverized state, should be moistened, and the bones thoroughly drenched. Finely-ground bones decay more than coarsely-ground. In order to ascertain every possible cause of failure, I procured some boiled bones, and making them up in a heap at the same time with unboiled bones, found that the former have not heated so well nor fallen to pieces nearly so much as the raw bones. *Stale* bones from a kennel, roughly pounded, would not heat, I am told, at all. Bulk of the heap is a decided advantage. Four cartloads in one heap heated much better, I found, than four cartloads in separate heaps. As the heat does not maintain itself well within a foot of the surface, it is useful to give the heap an external covering of the same material employed in the mixture. On the other hand, the quantity of ashes or sand employed may be reduced, I believe, to one-half of the quantity of bones. A bone-merchant has told me that, having made up a large heap, he turned it and watered it afresh at the end of a fortnight, and that at the close of a month very few whole bones remained. I may add the result of two trials made here this summer with late-sown turnips:—

| | Cost. | | | Yield. | |
|---|---|---|---|---|---|
| | £. | s. | d. | Tons. | Cwt. |
| $5\frac{1}{4}$ bushels of superphosphate per acre | 1 | 17 | 0 | 16 | $12\frac{3}{4}$ |
| 8 „ decayed bones . . . | 1 | 2 | 0 | 13 | 14 |
| No manure. Much less than . . | — | | | 1 | 0 |

These bones were from a small heap and not well decomposed. On two other lots, where the bones employed had lain in a large heap, and been better fermented, the yield was just even:—

| | Cost. | | | Yield. | | |
|---|---|---|---|---|---|---|
| | £. | s. | d. | Tons. | Cwt. | lbs. |
| $5\frac{1}{4}$ bushels of superphosphate . | 1 | 17 | 0 | 15 | 13 | 67 |
| 8 „ bones . . . . . | 1 | 2 | 0 | 15 | 12 | 0 |

The superphosphate always pushes on the turnips faster at first, and therefore is best for late-sown turnips. For those that are sown early, though I do not think that this mode of decomposition will supersede the use of acid, I cannot but hope that it may afford the farmer, in some circumstances, a useful choice. I should mention that salt has been thought to check the process, which is not surprising, as it is an anti-putrescent. As to the time during which the bones should lie in the heap, I do not feel sure whether or not the process of heating should be allowed to expend itself. I need scarcely add, what seems generally known, that before drilling this or other manures the compound should be mixed with ashes or some other medium which will drill readily, in order to diffuse it in the soil and give each rootlet of the young plant a chance of finding it.

*Pusey, Dec. 2,* 1848.

## XXIX.—*On the Best Mode of Managing Hops, in its various branches.* By Samuel Rutley.

### Prize Essay.

In presuming to compete with scientific persons and more able writers for the Society's prize on the above subject, it is under the impression that a plain practical statement is what is required; and although I may be more prolix in stating my views than persons more in the habit of writing would be, I hope—from nearly fifty years' practice and experience in the cultivation of hops in the counties of Kent and Sussex, and in various parts of the former; and as during the whole of that period a great part of my time has been devoted to it, not confining my observations to the results of my own practice only, but extending it to the practice of others—I may be able to give some information that may be useful to the young and inexperienced planter.

As no specific directions are given as to what is required from the writers of this Essay, as in others, in going into detail, I shall adopt that course which I consider would be the most plain, straightforward, and intelligible, by commencing with the first proceedings in hop-planting, and continuing on in regular course, with as little digression as is possible, through its various ramifications that come under the management of the planter, up to the sale of the hops, confining myself strictly to the Society's first rule for Essays, stating only as facts what are founded on my own experience and observation, referring to other sources only by way of analogy. The first thing that will naturally come under my consideration is—

### *The Soils and Subsoils best adapted for the growth of Hops.*

Although nearly the whole of the hops grown in this kingdom are grown in the following six counties, viz., Kent, Sussex, Surrey, Hampshire, Worcestershire, and Herefordshire, and principally in the two first named, Kent and Sussex, those two counties having grown on an average of the last 30 years more than 6-7ths, and last year 19-20ths of the whole growth of England; they are nevertheless capable of being grown to perfection on varieties of soils, but deep rich dry soils with porous subsoils are the best adapted. All retentive subsoils should be drained thoroughly at a depth of at least 4 feet, and from 16 to 48 feet distance between drains, as the subsoil may be more or less porous. On wet soils the plant will soon decay if the land is not underdrained, although great care may be taken to keep the water running off in the winter by open furrows, in every or every alternate alley between the rows of hills, for as the soil

must be full of water to the surface before the water will flow off at top, the roots of the hops will be continually saturated during the winter, and consequently they will be continually decaying; and although they may be annually repaired, it will not answer the planter's purpose to continue the ground in plant longer than from 8 to 12 years: such has been the case, and hops have been grubbed at earlier periods than 8 years, in consequence of the stock having decayed from the wet; but there is scarcely a planter now, who would think of planting a wet piece of land, but would underdrain it on some plan or other; yet such is the difference of opinion still existing on the nature and plan of underdraining, that I have frequently seen it very injudiciously done. But as draining is not the subject of this Essay, I shall be deviating too far from the path I have marked out to go into any minute argument upon it.

The soils adapted for the growth of the best sorts of hops, such as the Goldings and Canterburys, are deep light loams, or deep soils of a mixed nature, resting on porous subsoils, such as the sandy loams on a subsoil of chalk in the district around Canterbury, and in the vicinities of Rochester and Gravesend; but it is only where there is a great depth of mould that it would be right to plant hops on a chalk subsoil, for where the chalk is near the surface the plant will not flourish. The deep-moulded and stone shattery soils of the green-sand, or ragstone range of hills that extend from east to west nearly through the county of Kent, are peculiarly adapted for the growth of the finer varieties before mentioned, and there is no district where there are so many grown, or where, taking the quality of the hop and the quantity grown per acre, they are grown to such perfection; in East Kent and parts of West Kent, on the chalk formation, where there is a good depth of soil, they are grown of somewhat superior quality, in consequence of the hop being smaller, but not so great a weight per acre; the former growing in crop years from 10 or 12 to 15 and 20 cwt. per acre, and sometimes more, the latter seldom exceeding from 6 or 7, to 8, 10 or 12 cwt. So congenial is the rocky subsoil of this range of hills, not only for the growth, but duration of the hop-plant, that there are many grounds which are known to have been in plant more than 100 years, and are at this time in full perfection: there is a ground in the parish of Barming, near Maidstone, now in the occupation of John Whitehead, Esq., and for many years before of James Ellis, Esq., which I have known for more than 40 years, which when I first knew it had been planted more than 100 years; it is noted for growing large crops of good quality, and still continues to do so. There are many other grounds that I know, in several parts on the ragstone, that have been in plant nearly as

long, and now grow good crops of good Golding hops, frequently more than recently planted grounds, and less liable to disease. The roots of the hop are frequently found in these rocks at a depth of from 10 to 15 feet from the surface, where the stone has been taken out to that depth, showing that they are search ng down between the interstices for moisture and food.

The soil on this range of hills varies considerably in different districts, and in different parts of the same district, as it may be nearer the top or bottom of the range, being generally richer and deeper at and towards the foot than at the summit; but it is all kindly for the growth of hops. There is a narrow breadth of rather a tenacious and strong nature near the bottom of this range of hills on the south side, called the Coombe soil, which grows excellent Golding hops; and a district called Under-river, near Seven Oaks, on that soil, has been for many years noted for growing hops of the finest quality. I have hitherto only noticed the before-mentioned soils as being the best for growing the finer and better varieties of hops, as the Goldings and Canterburys; they are nevertheless capable of growing all the coarser varieties to perfection, both as to crop and quality; and a great many acres of those descriptions are now in plant, for although they make a less price in the market, they are not so subject to, and more likely to recover from, various diseases (which I shall enumerate under that head) to which the plant is liable.

Below the ragstone range of hills, either in the Weald of Kent or in Sussex, there are but very few Golding or Canterbury hops grown, nor does it answer the planter's purpose to grow them, for although there are varieties of deep-moulded and rich soils in those districts, the subsoils are mostly too retentive of water, or the situations unadapted for the healthy subsistence and growth of those varieties. The soils in those districts, on which the coarser varieties of hops, such as the Grape, the Jones, the Colegates, and various others are grown, are the deep alluvial soils near large rivers or the sea (but sheltered from the sea winds); the deep loamy soils on a sandstone rock, or on a gravelly subsoil, which are to be found, the former in the lower part of Kent and adjoining parts of Sussex, on the declivities and tops of the gently rising hills of those parts, on what is termed the Hastings-sand formation; the latter in parts of the Weald of Kent near streams and rivers, and in the valleys between the hills in Sussex and adjacent parts of Kent. Also the retentive clays of the Weald of Kent and Sussex, where there is a depth of top-soil, are very productive in growing hops in favourable years, but these, as well as all other wet subsoils, require to be thoroughly underdrained, or they will not produce so much, and the plant will soon decay.

Although I have not named all the varieties of soils that hops are and may be grown on, I have endeavoured, by stating the principal soils on which hops are grown in the counties of Kent and Sussex, to show that they may be grown on as great a variety as wheat or any other grain; and that the deeper and richer the soil, as with grain, the greater will be the produce, and generally better the quality of it.

The deep alluvial soils, or mixed with loam, which are calculated only to grow the coarser varieties, are the most productive; 30 cwt. and even two tons per acre have been sometimes grown on these soils: and it is in the eastern part of Sussex and some adjoining parts of Kent, where generally the largest crops are grown. The plant will not continue so long here as on the ragstone or chalk formation in Kent, although there are instances in Sussex of hop-grounds being in plant 40 or more years: on a dry loamy soil on a porous sandy rock, from 12 to 20 years is a fair average of years that the plant here stands good; and on wet clayey soils, where not well drained, 8 to 10, or at most 12 years. Before I leave the subject of soils, I should state that where old meadow or pasture land can be had for planting hops, it is in all cases most desirable, but the sward should not be pared and burnt, as would be advisable for green and corn crops; but be turned into the ground, so as gradually to decay, and become, as it does, food for the hop-plant. The next to be considered is

*Situations.*

The site of a hop-ground is of some importance, and a field sloping to the north is best, being more screened from the south-west winds, which are the most prevailing during the time of the growth; that aspect has more hours of sunshine than a south one, and not so scorching a heat, the mid-day sun not striking so directly upon it as on a south aspect. Flat low lands, although the best land, and generally the most productive and best sheltered from wind, are more subject to be blighted by the aphis than higher and more exposed situations; if on very high hills, the climate is too cold, and the crop small, as on the top of the chalk range in Kent; but the quality is good and seldom blighted.

*Preparing the Ground for Planting.*

In all cases, whether old meadow, pasture, or cultivated arable, a deep tilth is required, which is obtained either by trenching or ploughing, and subsoiling; the former being the best when well executed, the latter being the cheapest and most expeditious. Trenching is done by moving the ground two or more spits deep, and may be done either by burying the surface soil and bringing the under soil to the top, or by loosening and breaking the under

soil, and continuing at the top the upper soil, turning it over and breaking it on the under soil which has been loosened and broke; which is the best mode, will partly depend on the nature both of soil and subsoil: where the soil is deep, and the subsoil of a porous and stony or sandy nature, and where cherty or gravelly, it would perhaps be well to put the top soil underneath, as that description of under soil, although loosened up and separated at the time of trenching, is inclined to bind down and amalgamate again, so as to prevent the roots of the hop having free liberty of access; but on adhesive clays, or mixtures of clay with stone, it is best to continue the surface soil at the top. Advocates for bringing the under soil to the top argue, that as the hop roots very deep, it is putting the good portion for them to root in, and bringing the bad to the top, to be made good by applying extra manure: but on the other side it may be argued, that although the roots of the hop will go down very deep where they can get admittance, there are numerous rootlets and fibres that run about and spread themselves all over the ground close to the surface, taking in food for the plant, when it requires it most, at the time of throwing out the lateral shoots, the burr, and the hop; that putting the vegetable mould at the bottom is putting their natural food out of their reach; and that the tendency of the hop's root downward is a proof of its searching for a portion of its food among the inorganic substances contained there; and that, although the more volatile parts of a manure do not descend down to the roots lower than they are placed by digging or otherwise, the more heavy ingredients of it do, and particularly where the soil is loosened up, and made easier of access; that, upon the whole, it will generally be found best to loosen and break the soil to a depth of at least 18 inches to 2 feet, leaving the surface soil at top; and this may be done nearly if not quite as well, much cheaper, and more expeditiously, by the other mode of preparing the ground before mentioned, viz., ploughing and subsoiling. Before the subsoil-plough came into use there was no means of cultivating to the required depth but by trenching, although I have seen ground ploughed with a single furrow to a depth of 16 inches for hops, with a very strong Kentish wheel-plough drawn by 10 horses. The custom has been, as long as I can remember, to plough deep for hops; and with 6 horses and a strong plough, a furrow from 12 to 14 inches can be ploughed: for although trenching was admitted to be best, it was too tedious and too expensive to be generally adopted. But the subsoil-plough obviates the necessity; as turning over a furrow from 12 to 14 inches deep, as above, with 6 horses, and with 3 or 4 horses more, as may be required, to subsoil 8 or 10 inches lower, will move the land to the required depth of from 20 to 24 inches.

Read's subsoil pulverizer, which has obtained several prizes from the Society, is the best I have seen for that purpose. Some planters plough two furrows deep, bringing the under furrow over the top one; but there is no advantage attending that (as the same or less strength of horses required for two furrows at the same time will plough up one of equal depth to both), unless on meadow or pasture ground, and then it is necessary to plough two furrows deep to bury the top sward, that it may decay and not vegetate between the furrows, skimming it off to the depth of 3 or 4 inches, and then ploughing the second furrow to a depth of 10 or 11 inches more, and turning it over on the top of the other, making together the aforesaid depth of from 12 to 14 inches; and then to follow with the subsoil-plough as there stated. The cost of this mode, as here calculated, is—2 horses and man to skim off the turfs, at 8*s.* per day; if a boy to drive the horses single on the edge of the furrow (for it would not be so well for horses to walk in the furrow, treading the ground that has been pulverized and raised up with the subsoil-plough), 6*d.* per day more; 6 horses, man, and boy, to plough up the bottom furrow, 1*l.* 1*s.* per day; 3 horses, man, and boy, with the subsoil-plough, 10*s.* 6*d.* per day: altogether 2*l.* 1*s.* per day. But as the three operations must all be going on at the same time, there is a hindrance in following each other; in case of either having to stop, it hinders the whole, and they are longer turning at the ends than one plough alone; so that 3-4ths of an acre per day is as much as would be done, which, at 2*l.* 1*s.* per day, amounts to 2*l.* 14*s.* 8*d.*; allowing for wear and tear, and forging shares, coulters, &c., 3*l.* per acre would be ample for every expense: on arable land, where the turf-skimming is dispensed with, it would save 1-5th of the above; leaving the cost 2*l.* 8*s.* per acre. Trenching will cost from 8*d.* to 12*d.* per square superficial rod; and where the soil is stony and gravelly, so as to require a great deal of it to be pecked with a mathook or pick, it would be more; calculating the average price at 10*d.* per rod, is 6*l.* 13*s.* 4*d.* per acre, making a difference of more than half; but as in ploughing there would be headlands left, where, from their approximation to hedges, there are roots running out from the trees and underwood, on newly broken up land, those headlands requiring trenching would add to the expense 6*s.* or 7*s.* per acre more, making on newly broken up meadow or pasture about half the expense of trenching; but on arable land, where there is not that difficulty to contend with, the expense is little more than 1-3rd of trenching. Where only a small plantation is to be raised, and the planter has not sufficient strength of horses to carry on the work as it requires altogether, his plan is to trench; for, as I before observed, it is the best mode when well executed; for as there is

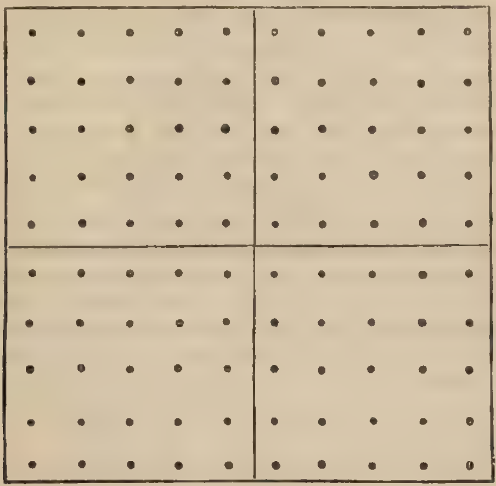
great room for the workmen to sham their work, without its being observable in appearance, the small planter has the opportunity of having the labour done more immediately under his own eye, and to see that it is well done; and as the additional expense of trenching is not an annual one, but spread over the whole time the ground continues in plant—20 or perhaps 30 years—it is not of that importance it at first appears. I have before, in speaking of soils, intimated that old meadow or pasture, where it can be obtained, is very desirable to plant with hops, which is very much adopted in the Weald of Kent and Sussex; and when the plant is worn out to take one crop of corn, and lay the land down again with proper seeds for meadow (it making better meadow-land than before broken up for hops), such being the covenants of many leases and agreements, and there are instances where every acre of meadow on a farm has at one time or other been planted with hops. If meadow or pasture land is trenched for hops, instead of being skimmed, ploughed, and subsoiled as before stated, it should be done on the same principle, that is, after having opened the trench and loosened the bottom a spit deep, to dig off the turf and put on it; then dig as deep a spit as the spud will take, which lay on the turf spit, shovel out the bottom of the trench and throw on the top, breaking it well together; then again loosen the bottom and proceed as before. After the ground has been prepared by any of the before-mentioned processes, and made level and fine by harrowing, rolling, &c., it is then fit for the next process, which is

### *Setting-out and Planting.*

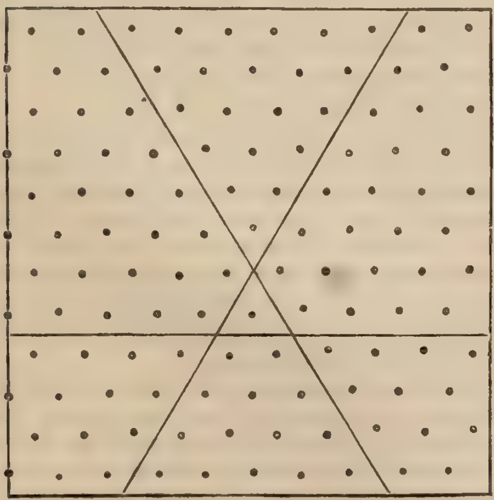
The general mode of planting hops is to place the hills at equal distances, either square or triangular, at distances as the judgment or fancy of the planter may direct him, varying generally from 6 to 7 feet. I have seen grounds planted in rows, at 8 or 9 feet distance between the rows, and the hills 3 or 4 feet distant from each other in the rows, but for what purpose I never could learn, unless it was for the convenience of the worst of all systems—ploughing between the rows instead of digging. I would advise every young hop-planter never to stick a plough in his hop-ground after it is planted before it is grubbed up; it tears and injures the roots, closes the ground with the tread of the horses, laying it in a state that requires more labour to get fine than when dug, and making it more unkind all the summer. It was much the practice from eighty to one hundred years back, when labourers were scarce, as the most economical, but ever since I can remember it has been condemned by all good managers, and is now almost but not entirely exploded. Of the two modes, square or triangular, I prefer and recommend the latter for several reasons—first, be-

cause there are more hills on an acre of ground at the same distance from each other, and because every hill stands as it were more by itself, admitting the sun and air in a greater variety of directions, and they are better and at less expense cultivated in the summer, by the nidget, all of which will be shown by the following diagrams :—

No. 1.

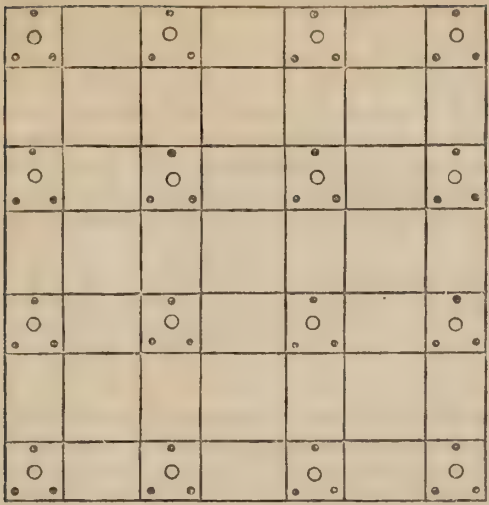


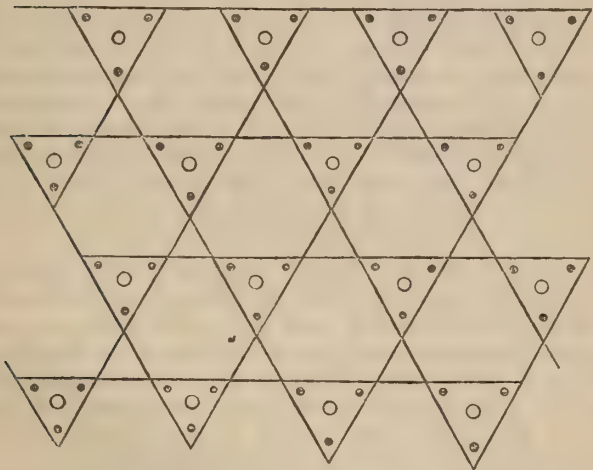
No. 2.



The two preceding diagrams contain each a square of 2½ inches, the dots being in each ¼ of an inch apart, which, supposing them to be hop-hills at 6 feet distance, is on a scale of 24 feet to an inch: No. 1, which is the square, having 10 rows across of 10 hills each, making 100; No. 2, the triangular plan, having 12 rows across of 10 hills each, making 120; showing that, where hops are planted at 6 feet distances, the triangular will have 120 hills, where the square will have only 100 at the same distance every way from hill to hill; and although No. 1 shows a distance between the outside dots and the outside of the square equal to half the distance between the dots, and No. 2 shows the same on three sides only, as every alternate row shows the dot on the outside line of the square, there is at the other end of the same rows a distance from the outside equal to the distance between the hills, so that the 120 dots in No. 2 occupy no more space than the 100 dots in No. 1, although the dots are at equal distances in each. It is only necessary to fix the eye on any single dot or supposed hop-hill in No. 2 (except outside ones), it will observe 6 more round at equal distance from it, with 6 spaces of the same distance, opening every one of them directly on the hill in the centre, giving free admission to sun and air; and then turn the eye to a single dot in No. 1, and it will directly discern the advantage of the triangular over the square plant in that respect; and the advantage of better and less expensive cultivation No. 2 has over No. 1 is shown by the three cross lines in No. 2 and two cross lines in No. 1, those in No. 2 showing that there are three spaces, or alleys, betwixt the rows of hills, and in No. 1 only two of equal distance, and where there is room for a horse and nidget. The advantage of having three ways is, that the nidget, going once in an alley, will cultivate all the ground; where there are only two ways it will require the nidget to go twice in an alley to do so, being a saving of one-fourth of the expense of nidgeting; and why it will do it better will appear when I show that, as 3 poles to a hill is the number most common and best, when 3 poles are set up to triangular plant, in a triangular direction as they should be, the nidget, in going three ways, and in every way close to the side where the 2 poles are, will cultivate the ground all round close to the hills, whereas in square plant, although the nidget goes twice in each alley, going on both sides, there will be ground left on each side of the odd pole (as it is called) at every hill, as here shown by the cross lines in the diagrams on the opposite page.

For the line being drawn where the outer hoe of the nidget will go, if the nidget is made of a proper width, it will, after having been drawn the three different ways in the triangular plant, have moved all the ground between the hills, whereas on the square, although the nidget goes twice in an alley, it is





plainly seen, as above stated, a piece of ground is left untouched. If 4 poles were put to a hill in the square plant, thus,  then twice in an alley would take all the ground, as in triangular plant; but where the hills are planted 6 feet square, it would give 4840 poles to an acre, which, in most cases, would be at least a quarter too many; but I shall elucidate that more plainly under the head *Poling*. I have been particular in endeavouring to demonstrate the advantages of triangular over square plant, although it is not of very material

consequence which mode the planter adopts; but as hops are a cultivation attended with a very considerable expense, every little saving (and particularly when it is of benefit to them) that can be effected should be attended to.

In planting triangular, I should not recommend more hills to be planted on an acre than if square, but at a greater distance, so as to have about the same number to an acre. The following table will show the number of hills on an acre of square plant, and triangular, at the same distances, and the difference:—

| | Square. | Triangular. | Difference. |
|---|---|---|---|
| 6 Feet distance between the hills | 1210 hills | 1406 hills | 196 hills. |
| 6 „ 3 inches „ | 1117 „ | 1296 „ | 179 „ |
| 6 „ 6 „ „ | 1031 „ | 1194 „ | 163 „ |
| 6 „ 9 „ „ | 957 „ | 1103 „ | 146 „ |
| 7 „ „ | 889 „ | 1025 „ | 136 „ |

The distance that is best depends on the soil and sort of hops planted; some soils are more productive of bine than others, and so are some varieties of hops; therefore, where it is intended to plant Golding, Canterbury, or Colegate hops, as they produce more bine, they require longer poles, and should be planted at a greater distance; or on deep-moulded rich soils there will be a greater production of bine, from all varieties, than on thinner and poorer soils. About 1200 hills per acre* are as many as there ought to be for the least biny soils and sorts, if it is intended not to exceed 3 poles to a hill; or if it is intended for 4 poles to a hill there should not be more than 1000 hills to an acre; the more biny sorts and soils from 1000 to 900 hills, 3 poles to a hill; for in no case would I recommend 4 poles to a hill for that description.

The planter, having prepared his ground, fixed upon the sort he intends planting, and made up his mind as to distance, is to set out the hills, which is most accurately done at first with a chain, and not depend on a line of small cord, or string, as many do; for, as a line will stretch or shrink, as the atmosphere is damp or dry, the hills will be inaccurate as to distance and the rows winding. The better plan is first to set out with chains (two land-measuring chains will answer the purpose very well), to set out distances of 9 or 10 hills, as there may be length of chain, putting down sticks, which we will term station-sticks, all over the ground at that distance, and then with a line marked with feathers, or coloured worsted, or something equally conspicuous, at the distance the hills are intended to be, and of a length equal

* In naming round numbers, I mean such distances in the table above as approach nearest in number of hills per acre to those round numbers named.

to the distance of two stations, 18 or 20 hills, as the case may be, proceed to set out the hills all over the ground, keeping the line (which should be well stretched before it is marked) sufficiently tight to reach exactly the length of two stations, putting down a stick to every mark on the line, setting it out in rows of two stations' distance first, and then stretch the line across between the sticks in the rows, putting down a stick to every mark as before, which will finish as proceeded with. This method will set them out perfectly correct if care be taken with the chains; for as the chains will not err, neither can the line err when made to reach the station-sticks set out with the chains; small sticks or reed, cut about 1½ feet long, are what is required. A man, with an assistant and two boys, will set out complete 3 acres per day. For a man who understands the work, 3*s.* per day; assistant, 2*s.* per day; two boys at 6*d.* each, 1*s.* per day; making 6*s.*, which would be 2*s.* per acre.

## *Planting.*

Before I begin to describe the method of planting, although I have, in describing the soils calculated for growing hops, shown in some degree the soils adapted for different varieties of hops, it would be well to place here more immediately under the view of the reader the varieties of hops most generally planted, and the soils best adapted for each.

Golding's, which are reputed to have taken that name several generations back, from a gentleman of the name of Golding, who first raised them, and whose descendants, some of them, are now hop-planters in the county of Kent.—This variety is undoubtedly the finest, richest, and most valuable of any grown, varying in quality, like all other varieties, according to the soil on which they are grown; the soils best adapted for their growth are deep rich soils, on calcareous subsoils; require poles when in full plant from 14 to 18 feet long.

Canterburys partake somewhat of the nature of Golding's, not so thick or so strong a hop when dried, but equally fine if not more so in flavour; are well adapted for brewing fine ales for keeping; they require the same description of soil to be grown on as Golding's, run rather more to bine, the hops smaller, require poles from 14 to 20 feet long. I should suppose the name to be taken from being first grown at or in the neighbourhood of Canterbury.

Grape, which take their name from growing in clusters like grapes, are a more hardy variety; will grow on the same soils as the two above sorts, also on clayey soils with retentive clayey subsoils, and upon almost all varieties of soils; do not produce so much bine as the two first, but more productive in hops; require

poles from 12 to 14 feet, and in some instances 16 feet long; there are two or three varieties of grape, decidedly differing in some respects; there are the yellow, the green, and Cox's grape. The first are ready to pick earlier and are of better quality than the other two; on some soils they grow nearly equal to Golding's, particularly in the vale of Holmsdale, in Kent, near the foot of the chalk hills; there they grow small, and the crops not large; do not require often more than 12-feet poles. The second, the green, or Mayfield grape, which is the sort principally grown in Sussex and the Weald of Kent, and is often very productive. The third, Cox's, were originally grown in a very old piece of ground at Wateringbury in Kent; that was fifty years back in the occupation of a Mr. Walter Barton, and for many years after of Jas. Ellis, Esq., of Barming, and more recently of Alderman Lucas. From this ground, if I am not misinformed, the sets were cut which Mr. Cox, of Hadlow, has grown, and distributed as a very useful sort (which they are), and by way of distinction called after his name. I knew this ground well forty years back. I have since planted some Cox's, and they appear to me to be the same variety of grape; they grow more in clusters, but not so large as the green or Mayfield grape, are great croppers, run to as much if not more bine, and require quite the same length of poles as those do.

Jones's, a very different variety of hop from any before named, much more extensively planted than twenty years back, are very much improved, but not a new variety. I remember my father growing them fifty years back, but they are now grown very superior in quality; they, like the grape, will grow on almost any soil, requiring short poles, the refuse from the grape being sufficient for them, from 8 to 10 or 12 feet being a sufficient length, they being inclined to extend their heads and lateral branches from pole to pole, and from hill to hill, and the hop growing and flourishing more under what is called housy bine than any other variety; they are of better quality, and make more money in the market than grape, but do not generally grow so many. I think it is right for every planter to have some of them, for, as they take poles that would be otherwise of no use except for young hops and to burn, the expense of poling them is much lessened.

Colegate's are a variety very distinct from any of the former; were first propagated from a plant growing wild in a hedge on a farm at Chevening, Kent, by a gentleman of the name of Colegate, who then occupied the farm; they are a very hardy but backward hop, will grow on any soil, run much to bine, and require as long poles as Golding's; the hop is very small generally, when quite ripe before they are picked they have a thick rich

appearance when dried; but the smell and flavour is not good, and some brewers object to them; they, however, generally make as much money in the market as grape, and sometimes a little more. As they are later in the year before they require picking, it is well to have a small proportion of them on that account for latter picking. I have grown a few of them the last ten years, and they have grown a larger average crop than any other sorts I have grown. I had my sets from Mr. Colegate, a son of the gentleman who raised them; they were cut sets, but never since they have been planted have I had occasion to replant or even repair a single hill; they are the most sure growers of any variety, but they are remarkably bad climbers, requiring to be ladder-tied continually until the bine reaches the top of the pole.

These five varieties are the principal grown in Kent and Sussex, but there are others which are not so distinct as these, but partaking a little of the nature of one or the other, and inferior: there are the Wildings, Golden Tips, Ruflers, Flemish, and others; but as any of these are now but little planted, and as little to be recommended, I will not trouble the reader with any more minute description of them, but will now go back to where I digressed to describe the varieties of hops, and the soils adapted to them, and endeavour to show the best method of planting.

Hops are propagated by cuttings from the grounds already in plant, taken at the usual time of dressing them in the spring of the year, and either planted where they are to remain the same year, or planted in beds and removed to their destination another year; the first are called cut sets, the last bedded sets: by one of these two plans are all the hop-grounds in Kent and Sussex, and I believe elsewhere, raised.

Mr. Lance, in his work called 'The Hop Farmer,' goes into a scientific description of the manner of raising the hop-plant from the seed, intimating it to be the best plan of raising a hop plantation. Without at all doubting the correctness of the description there given, from the time of planting or sowing the seed until its development, I am entirely at a loss how a plantation of any extent can be directly raised from seed; for it is well known, although Mr. Lance does not exactly state it, that the seed of the hop, however well impregnated with male farina, does not produce to a certainty the same variety of hop as that from which it was taken; from a quantity of seed sown there would be several varieties, and but very few plants of that variety from which the seed was taken. I once grew a great many plants from seeds of the Golding hop; there was nearly an equal number of male and female plants, but there was not one female plant that produced a hop at all like a Golding hop, nor was there a single plant amongst them all that produced a hop that I would have raised a plantation of, or was

not very inferior to any hop I ever saw growing in a plantation. I am aware that from seed a new variety of hop is produced, and perchance a good one, and from which a small number of plants may be taken and propagated, but it must be by the usual method of cutting from the parent stock that the variety can be extended, so that by cuttings only can a plantation be raised to any extent. If it is wished to raise a plantation quick, if the planter has already bedded some last year's cuttings, or bedded sets can be purchased, by planting them the plant will come to bear sooner, and will sometimes produce 3 or 4 cwt. per acre the first season after planting, but not so many as cuttings of the same year which were planted at first where they were to remain, for moving them from the beds checks their growth, having to strike their roots afresh in their new destination; and although they may produce more hops the first and second years after planting than the cuttings which are planted to remain, the third year the latter will have quite caught the others, and oftentimes produce more hops that year than those planted in the same year with bedded sets; so that, unless a planter has some object in view to induce him, or has a quantity of bedded sets by him, the best and cheapest way is to plant cut sets where they are to remain; 5 cut sets is a sufficient number to raise a hill, and what is most generally planted: 1200 hills to an acre would require 6000 sets per acre, which, at 6*d*. per hundred, a general price, would be 30*s*. per acre; it requires 3 bedded sets to a hill, or, mixing the weaker with the stronger ones, 3600 per acre, which, at the general price of 2*s*. 6*d*. per hundred, is 4*l*. 10*s*. per acre; or if the planter raises them in beds himself, there is a considerable expense attending it, although some saving would be made. Whether the planter purchases his sets or cuts them himself from his own grounds, it should be from a good healthy stock, and where the variety is true that is intended to be planted; also care should be taken that the cuttings from the male plant are kept distinct from the others, or they are likely to be very irregularly distributed over the ground, instead of having them, as they should be, at distances of 10 or 12 hills from each other, so as to have 1 male-planted hill to 100 or at most 150 hop-growing hills.

A great difference of opinion exists among experienced planters as to the utility of the seedy or male plant, some eradicating them from their plantations as entirely useless. It is not, I presume, expected that the writer of this essay should enter into a scientific description of the nature and operation of the male plant, but from practical experience I am positive as to its beneficial effects. Nearly forty years since I took a farm on which there was only one hop-ground of about ten acres, in which there was not a single male plant; they were Canterbury hops—they

went up large and long poles, produced a great quantity of bine and a fair quantity of burr. The hops were generally small, loose, and *hover*. Being at that time satisfied, from what I had before seen, that the male plant would improve them, I planted one hill in every 144 (12 each way distant) with them, taking up the stock in the hill, thoroughly eradicating every root, filling up the hole with a mixture of dung and mould well decomposed, and planted cuttings of the male plant. The first year they produced no seed or farina, nor was there any difference in the hops grown that year; the next year, although the male plants were not arrived to their full strength, they produced a considerable quantity of the farina, and when the burr came into hop a considerable difference appeared in those growing around and near the male plants and those at a greater distance from them, those hills that were near having the hops larger and more firm, closing at the tip, whilst those at a distance were as loose and hover as in the previous years; the next year, when the male plants had attained their maturity, there was but little difference observable between the hops on the hills near the male plant and those at the greatest distance from them, all the hops grown being larger and firmer, with a very few of those loose open hover hops which had before been grown generally on that ground, and for ten years after, the time I continued to hold the farm, I saw every year the same advantage by continuing the male plant. Why all the ground did not feel the same benefit on the first year from the farina of the male plant as those more near was, no doubt, from the male plant being young and not producing sufficient farina to benefit the whole, as ever after, when the male plant became as strong as the others or more so (as they generally are), there was no perceivable difference all over the ground, but all appeared to be benefited by them. I have continued to have ever since in all my hop-grounds, as I always had before, about eight or ten male-plant hills per acre, putting in that number whenever I raise a new plantation, and I recommend all young planters to do the same. Mr. Lance, in his 'Hop Farmer,' writes most decidedly in favour and gives a scientific description of them.

Before planting the cut sets many planters dig out a hole around the stick where the hill is to be, about 10 or 11 inches square, and the same depth, taking out the soil and throwing it about the ground, having some good compost of dung and mould or rich mould ready prepared at hand to fill up the holes with, which should be trodden lightly in with the feet, and then a little fine soil put over it, taking care to put the stick down again at the same place it was taken from, which should be the centre of the hole. This plan of holing, as it is called, is very necessary on stiff land, where the ground ploughs up in whole furrow, and

is a great assistant to the growth of the set. Sometimes where the planter has no compost or fine vegetable mould to put in the holes they are filled up with fine soil from the surface which has been run with the frost and harrowed fine, treading it in gently as before, to have a firm hold of the set, leaving a little loose on the top to keep out the drought and prevent it from cracking. The sets will take better this way than if planted in the stiff furrow, hard as it is ploughed up with the exception of being made fine a little way down at top with the frosts and harrowing.

But where a good tilth can be got by deep ploughing and subsoiling, or is made by trenching, there is no necessity for holing, the expense of which may be saved, and the planting proceeded with more expeditiously; and as manure put in the holes is to assist the growth of the sets as soon as they begin to strike root, so should the ground be manured at the time of ploughing or trenching, particularly if it is arable land. It will require more manure to go over the ground than to fill up the holes, but the roots will derive more benefit, for when they extend beyond the holes there is no manure to assist any farther; but where the manure is all over the ground the roots of the plant will extend all over the ground the first year, and consequently derive much more advantage from the manure. Where the land is old meadow or pasture fresh broken up, although manure will do no harm, it does not absolutely require it; and as much organic matter is contained in the sward and roots of the different grasses, lime spread on at the rate of 200 to 300 bushels per acre, and nidgeted in after the hops are planted or in the following autumn and dug in, will be of greater benefit in most cases to such land at first than dung; but more of manures under that head. To proceed with planting: as I before said, five cut sets should be planted to make a hill, which should be put in with a dibber around the stick, leaning the tops together to form a compact head, sloping the bottoms of the sets a little out all around, tightening them by putting in the dibber again, pressing the earth up close to every set, laying a little fine earth and marking a small circle around the top to show where the sets are planted, putting the stick and leaving it in a slanting direction over them as a guide when nidgeting to keep the horse and nidget from injuring or disturbing them. A man, when the sets are laid out five near each stick, will plant 600 hills per day; a boy will lay out for two men, therefore two men at 2*s*. per day each and one boy at 6*d*. per day will plant an acre of 1200 hills for 4*s*. 6*d*.

If bedded sets are to be planted it is then necessary to dig out holes, and larger than for cut sets, leaving a small conic mound of earth in the centre of each hole, on which put three bedded sets regularly around it, spreading the roots even and pressing

them close to the mound of earth, bringing the tops of the sets to a level with the surface; then put on the prepared compost and some of the surface earth, treading it evenly and gently on the roots, covering all over with loose fine earth, marking it round, and sticking in the stick as directed for cut sets. The roots of bedded sets should only be trimmed and cut off where too long to lay in the hole, for trimming them up short to within two or three inches of the set, as I have seen sometimes practised, is taking away the little rootlets and fibres that more readily strike root and take in food for the plant. The cost of planting bedded sets is from 1*s.* to 1*s.* 2*d.* per 100 hills, digging out, planting, and filling up. After the ground is planted either with cut or bedded sets, as soon as it is dry and the weather permits, the land should be cultivated well and deeply with a nidget. The best and proper time to plant cut sets is as soon after the sets are cut off the old stock as can be, which will do some forward springs and on dry soils in February, but principally in March; but if let alone until after the beginning of April, should the weather set in dry it is hazardous, as many of the sets may not strike root for want of moisture; and although I have seen them occasionally succeed after the middle of April it is very wrong to delay doing it so long if it can possibly be avoided.

Bedded sets are best removed in the autumn if the land is prepared and time and weather permit; if not, as early in the spring as possible.

If cut sets are planted the ground may be cropped between the rows of hills, such as one row of potatoes, one or two rows of mangold-wurtzel, carrots, or swede turnips, which will not prevent the ground from being cultivated during the summer, and will help to pay rent, taxes, and cultivation for the first year. But if bedded sets are put in, they will require small poles of six to eight feet long, and as I have said a few hops will be grown, the roots and fibres will be spreading over the ground towards the latter end of the summer, so that it will be wrong to attempt to grow any other crop between the rows of hop-hills; and it is well here to remark that it is wrong at any time or under any circumstances to grow anything besides hops in a hop-ground, for when we look at the great quantity of bine and the great weight of dried hops grown, and the same year after year, either more or less, it must be evident that the ground has plenty to support without finding food for any other plant.

After the ground is planted with cut sets and planted with potatoes or any other roots, as before mentioned, little more requires to be done during the summer of the first year than what is required for the root-crop grown there. In the course of three or four months, if the plant meet with no obstruction from any of

its numerous enemies (a short description of each I shall give in its proper place), it will be throwing out young bine, which will be running and spreading over the ground, so that it will be necessary to tie it up in a bunch or around the stick to keep it from being cut or torn when cultivating the ground by the hand-hoe or nidget, for the land should be kept in a good state of cultivation and free from weeds throughout the summer. In the autumn of the year, when the sap is down and the young bines are become *scar*, they may be cut off, and a little mound of earth, about the size of the crown of a man's hat, put on the hill to keep the wet from the stock, taking care to have it levelled down before the plant shoots in the spring. Some leave the bine on, and the hill remains as it is until after the ground is dug, and then cut off the scar bine and dress them as they do the older plant; but I prefer the former plan, and to pole them very early in the spring and dig all the ground directly it is poled, for in digging them before poling (I mean the young planted ground) frequently a hill is inadvertently or carelessly dug up, but when poled the poles act as a guard to the hill. For poling the first year after planting with cut sets rather larger poles are required than are wanted for bedded sets the year they are planted; but old refuse small poles from eight to ten feet long are generally sufficient; and as when they are so poled the proceedings generally will be the same as with older hops, I will therefore now describe the annual cultivation of hops, beginning with the first process in the spring, which is

## *Digging the Ground.*

Digging is done with a strong three-forked tool, called a hop-spud, which forks are made broad and flat, or more square, according to the soil to be dug. On stiff soils, where the ground hangs together and the spit is necessarily turned over, the flatter and broader forks or speens are best; but on stony and rocky soils, where there is more difficulty in getting the spud in and more strength is required, the square speens are the best: such ground, breaking up deeper than the spud goes, is poked over by the tips of the spud; at the same time the upper part is turned on the top of it. An adept will proceed in this way with more ease and dig it deeper than when he is obliged to lift and turn all the ground. Care should be taken that the ground be all moved; the manure and weeds, if any (as there often is after a mild autumn or winter), should be well buried; and as it may be made to appear well to the eye when not well done, it requires a master's or bailiff's strict attention where many diggers are employed. The next process as soon as the ground is dry and weather permits is

*Dressing or Cutting,*

which is done by a boy or woman opening around the stock of the hill with a small narrow hoe or pecker, a little below the crown of the hill; then a man follows with a knife similar to a pruning-knife and a small hand-pecker, with which he clears out the earth on the crown of the hill between the sets or shoots of last year that were tied to the poles, and which, from having earth put on them the preceding summer, swell out to four or five times their original size, and form what we call sets or cuttings; and it is the cutting them off at the right part that should be particularly attended to, or great injury may be done: it is therefore necessary that the person cutting them should ascertain exactly where the crown of the hill is, that he may not cut them too low or too high; the place where they should be cut off is between the crown of the hill and the first joint, for it is around the set close to the crown where the best and most fruitful bine comes. If the set is pared off down too close to the stock or crown it takes away the part from where that bine comes, as little buds are seen ready to shoot forth at the time of cutting, which if cut off the bines come weakly and few; on the other hand, if the set is cut off above the first joint, which sometimes will be the case if the man in cutting does not pay the attention to it he ought, the bines which come from that or any other joint higher up the set grow fast, but are coarse, hollow, or what we call pipey, and unproductive; all such should be discarded at the time of tying: consequently the operation of cutting or dressing, on which the future well-doing of the plant so much depends, is not left so much to the judgment or skill of the operator as to his care and attention. Many planters have their hops dressed by the day, paying extra wages to persons in whom they can confide to do it with care. After all the old bine and runners, as the roots and small rootlets near the surface are called, are cut and trimmed off clean, some fine earth is pulled over the crown and a circle made round with the hand-pecker to intimate where the hill is before the young shoots appear. If sets are required to plant a new ground or for sale, such as have two or more joints are selected; but where it is intended that sets should be saved for planting, the ground should be looked over the previous summer, and such hills as are not true marked, as well as the male hills, that no sets be cut from the former, and that the latter are not mixed with the others. The time for cutting is as soon as the ground is sufficiently dry in the spring, and it should be completed by the 25th of March, but it depends much on the forwardness of the spring, for if the young shoots are far advanced it is not so well. Digging may be done any time during autumn, winter, or spring

when the ground is dry enough, but should it happen that the weather does not permit, or from any other cause the hop-grounds are not all dug before the time for cutting, the hills must be thrown down and cut, and the digging done afterwards. The price for digging varies from 1*s*. 3*d*. to 2*s*. 6*d*. per 100 hills, according to the nature of the ground and distance of the hills from each other, so that from 15*s*. to 25*s*. per acre is about the range, the most general being about 18*s*. or 20*s*. per acre. Cutting when done by piece is 6*d*. per 100 for opening and cutting. After cutting, the next labour to be done in a hop-ground is

## *Poling.*

All such poles that were in use last year as were considered fit to put up in the same ground again being put up in stacks, and new ones brought to the stacks or laid around the outsides of the ground to supply those cast off at stacking time the preceding year, it is best to commence putting them up as soon after cutting as the ground will do without closing it too much by treading, and not to wait to see how the bine comes, as is the practice with some planters; for it is better to change some poles afterwards where they prove to be too large or too small for the bine than to be behind, and the bine running about the alleys, liable to be injured during poling and sustaining injury from not being tied to the poles; and as the object in waiting is that the polers may place the poles to suit the apparent wants of the hills, it is not possible at this stage of the growth of the bine to ascertain which require the longest and largest, and where some accurate idea may be formed there will be a difficulty in getting the men to attend to it properly. Every planter knows what poles are suited to the ground, and has those he considers best adapted; the better plan is to pole every hill (except fresh-planted ones or very weakly ones, which should be marked at the time of cutting and very small poles put) all alike, having one of the longest, middle size, and shortest poles to each hill, and then have them looked over, changed, and regulated after the poling is done, as it can then be better seen what is required: it is attended with a very little expense, and where the hills are kept repaired and marked to have small poles a very little changing of poles is required, but where it does require doing it will pay the planter well to do it.

Three poles to a hill is the number most generally put, which should be placed in a triangular form, as before shown by the triangular diagram, and put in the ground to the depth of as many inches as the pole is feet long, or an inch or two more is perhaps better; but care should be taken that the pole goes to the bottom of the hole previously made by an iron bar, called a

hop-pitcher, the point of the pole being forced into the ground below the bottom of the hole to make it stand firm, the poler at the same time poking in a little loose earth to fill up the cavity unoccupied by the poles, and if required to make it stand correctly to tread it up with his heel; for it is very desirable that the poles at each hill should stand in a right position, the bottom bend or crook, if any, projecting towards the centre of the hill, to be more out of the way, so that the bine be not broken by the horse or nidget, and the tips of the poles turning out from the centre to prevent the bine from being too rough and housy at top, keeping the pole nearly upright, that the lateral branches may spread out equally around the pole. For the better and neater execution of the work of poling a line is used which is stretched over the centre of a certain number of hills, from 20 to 30 as the line may reach, pitching the holes at equal distances from the centre of the hill, but the holes on the side of the line where the two poles are to be put up must be nearer the line than where the odd pole is to stand to be so, thus—

From 18 to 24 inches is a good distance for the poles at the same hill to be from each other, as the hills may be at a greater or less distance apart, or as the sort of hop grown may be more or less biny, that is, 24 inches where there is likely to be a great quantity of bine, and where the hills are at the greatest distance: many planters put them much nearer together, but keeping them at as great a distance as the width of the plant will allow; with leaving sufficient room for the horse and nidget admits of the poles going more upright, and at the same time a better circulation of air between the poles at the same hill and less liability of the bines dropping their heads from one pole and going up another. The old poles should be tried by treading them with the foot or hitting them gently with the pole of the ax when sharpening them just above the sharp; for it is at that part of the pole that has stood the preceding years just level with the surface of the ground where it is most likely to break, and if not tried in that way those poles where the sharp has not been broken off are likely to break when put up and loaded with bine, doing great injury, but no precaution will prevent the old poles breaking down sometimes with high winds, and particularly when heavily laden with bine and hops.

When the ground is poled, if the bine is not in the way, it should be nidgeted and got into a fine deep tilth as soon as possible; but whether there is an opportunity of nidgeting or not, as soon as the bine is long enough to reach the poles it must

be tied up. The cost of labour for poling and sharpening down is from 1*s*. to 1*s*. 6*d*. per 100 hills of three poles, according to the size of the poles and nature and state of the ground for pitching the holes. If new poles are required to be carried from the outside of the ground to some distance in, the poler is paid extra for it, according to distance and size of the poles, from 1*d*. to 3*d*. per 100 poles; but if they have been carried in and put up to the stacks or laid in convenient lumps over the ground, then nothing is paid to the poler extra. Tying up the bines, or as it is called hop-tying, is generally done by women, who take them to do at so much per acre, with the understanding that they are to keep them tied up as long as they can reach them whenever they require it, to pull all weeds and surplus bines out of the hills, and strip the leaves off at the bottom and some of the lower branches if required. A woman who has a family with two or three girls old enough to assist her will take and do four or five acres, single women about two acres; if a woman takes more than she is able to tie in proper time, and the bines are not tied to the poles as soon or soon after they reach, but left untied, they will twist up together, and a great many more than required go up one or two of the poles, so that much injury is done and many of the heads broken off in separating them to tie up the poles; they are thrown backward in their growth and do not grow so well for some time afterwards. I would advise all young planters not to let any of their tiers have more than they can manage well, or if any get behind to put others to assist them. Tying is a process that requires great care first in selecting the best bines, which are not always those that are forwardest. All rank pipy bines, where there are, or there is likely to be, sufficient without them, should be pulled out, as they are not so productive; they climb the poles fast, having their joints a great distance apart, but do not branch down or hop so well. Many planters send persons before the tiers to pull up such bines, and then the tiers can take the best to tie to the poles, which is done with rushes, sedge, or old matting, but most generally with rushes, which are the best when they can be got. Three bines to a pole are most generally tied up when three poles to a hill; but some have only seven bines to a hill, two each to two poles and three to the odd one, but the better plan is to have three to every pole; for they are liable to accidents, and when one out of two is broken the one bine left is not sufficient to a pole to produce a crop, but when one out of three is broken and two left there may be: too much bine is often an evil, but where that is expected it is better to have a less number of poles than to put less than three bines to a pole. Large crops of hops are grown sometimes on only two poles to a hill, from 20 to 30 cwt. per

acre, in the lower part of Kent and Sussex, and I once knew an instance of a ground of four acres in the parish of Cranbrook, Kent, growing two tons per acre of 1200 hills on two poles to a hill: it was in the great crop year of 1826. It is a wrong idea to think of increasing the crop generally by putting four poles to a hill, when it is often lessened by it. I have seen frequent instances of it, particularly among Golding hops, in Mid-Kent. I was in two different grounds last year, both Golding hops, part of each being poled with three poles to a hill and part with two poles, and in both cases there were *most* hops grown per acre where there were *only two* poles to a hill. I do not state these cases to show that I consider two poles to a hill to be best generally, but only in particular cases where there is a great quantity of bine grown and the hills near together, for I consider three poles to a hill the best adapted in every respect; and on grounds and of sorts of hops where much bine is expected I would plant the hills at such distances as three poles to a hill would suit rather than have them closer and only two poles. But as we cannot always judge how a piece of a ground may turn out as to bine, if the hills should be planted close and the piece should turn out very productive of bine, so as to be too much with three poles, I would then put two, but in any case tie three bines to a pole. In almost all cases I should say four poles to a hill is too many, except where the distance is very great from hill to hill and the plant square, or where the stock has been drawn with large poles and likely to come weakly; four small poles to a hill in that case would tend to strengthen the stock and probably produce more hops than if three poles and larger ones are put; but this is an exception, for a good manager will take care not to injure his plantation by over-poling—he will be careful to adapt his poles to his plant, for he knows that it is not the number, but the size and length of the poles, that draws and strains his plant; he is consequently careful not to over-pole, that is, to put larger poles than are necessary. I have been led into this digression from the subject of tying in endeavouring to give a reason for my preference in all cases of tying three bines to a pole. It is not, however, necessary for the hop-tiers to wait until there are three bines for every pole long enough to tie, that is, for the hills to furnish, as they term it; but the tiers should begin as soon as some will reach the poles, tying up such, and go round again, keeping them tied up as they get long enough, and when every pole is furnished with three bines pull the remainder out of the hills, reserving two or three in case of an accident to any one of those tied up at the hill. The bine should be well tied to the pole at the bottom where it first reaches it, but they should not be tied very near the head, taking care that the

top rush is put round below the second joint, for when a bine is tied only just below the head it prevents its going up the pole, and causes it to bend out below the rush. After the poles are all furnished with bines the tier has then only to attend to the progress of them up the poles, tying up the heads that are hanging far away from the poles, as to have no chance of getting to the same pole again without; but after a high wind hundreds of heads of bines will be hanging away from the poles, but when the wind is still they will most of them get back again, although many may be 12 or 14 inches away. It is therefore very wrong to tie them up until the wind has ceased and time left for those to regain the poles that will, for the less the bines are tied round the poles after they are got once well attached to them the better; keep them well rushed around at the bottom, but higher up only what is quite necessary, for it is the nature of the bine to cling to the pole when once put there. The rush should at all times be tied only in a slip knot to give way as the bine increases in size; if a fast knot is tied and close and tight to the pole, the bine will often come quite asunder with the rush, so that the head will drop and die, when the bine has grown out of the reach of the tiers: the last thing they have to do is to clear out all the fresh-grown shoots (as they will by this time have many), and all the surplus bine left in before, and to strip off the leaves and branches from one to two or three feet high previous to the hills being earthed in, but at what time of the year this may be depends on circumstances: in forward springs and when not checked by the flea, the bine will be forward enough to begin to tie the latter end of April, sometimes by the 18th or 20th, particularly young ground or any others that were not earthed in the hills last year; but the forwardest bine is not always the most productive of hops. I have known bine that has been kept back first by cold weather and then by flea so as not to furnish the poles before the middle of June, and then a fair crop grown; but about the beginning of May is the most general time that the bine will be fit to begin to tie, and then the process of clearing out, &c., previous to earthing, as before mentioned, will be about the first or second week in June, as the weather and other circumstances may have been more or less favourable to the growth of the bine since they have been tied; sometimes, when the aphis blight has been severe, they have been completely stopped from growing before this time, and in some years (as in 1802 and 1825 particularly) never recovered.

Before I close the subject of tying it will be well to state that a plan adopted when any of the heads of the bines are broken off by wind or any accident, and the bine too far up to be taken down and replaced by another, or when there is no other to

replace it, is to make heads; which is done by taking one of the best lateral branches (for there will soon be two at every joint after the head is broken off) about 4 or 5 feet from the ground, cut off what is remaining of the broken bine above it, pull off every other branch on the same bine, tying that around the pole; it will go up the pole, throw out lateral branches, and grow hops; and all the other branches should be taken off, in order to throw all the sap to strengthen the one tied to the pole. The price of tying is about 10*s.* per acre of 1200 three-poled hills, where they are cleared out and stripped, and about 8*s.* where they are not stripped and cleared out before earthing. The stripping is much more practised in Mid-Kent than in the Weald and in Sussex, and the Golding hops do more require it; some planters give them a second stripping in July, about the time they are coming into burr, which is called "branching;" and I have seen it done up to a height of more than 5 feet from the ground: it is sometimes done with a view of checking the mould, by admitting a more free circulation of sun and air at the bottom; but its effect on the mould I think is doubtful. It certainly gives an opportunity of the ground becoming drier; and as the Goldings do not hop down generally so low as many other sorts, there may not be any less hops in consequence; but branching is not so much practised now as twenty or thirty years back. In those varieties that grow hops near the bottom of the poles, it must be wrong: I never branch, consequently do not recommend it. I strip before earthing, but not high, Golding's, and other biny varieties, from 18 inches to 2 feet; but grape, Jones's, &c., only to the first joint at the back of the poles, and this more from its having a neat appearance than any good that I know it does.

I will now proceed to state the different modes of summer cultivation, which, whatever mode be adopted, should be done in fine weather and when the ground is sufficiently dry. Where the nature of the soil permits there is no better mode, nor any more universally adopted, than horse-hoeing, or what is locally called "nidgeting," or, in some parts, "shiming," which is done with one or more horses, with a man to hold and a boy to lead or drive, which should be begun as soon after the hops are poled as it can be, getting a deep fine tilth as soon as possible, which may be done best on some soils with a strong nidget and two or three horses, going into the required depth at once; other soils are better brought fine by getting into the ground gradually with one horse and a lighter nidget, and going over the ground two or three times before the required depth is obtained, which would be at about the same expense as the other, for, although it takes a longer time, the other employs more horses. Nidgeting should be done several times during the summer, up

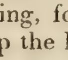
to the time of the burr coming into hop, doing it shallower as you approach nearer that time; for after Midsummer the young rootlets and fibres will be spreading themselves all over the ground: it would be doing an injury, then, to go very deep. It is nevertheless essential to the benefit of the plant, that whenever the ground becomes bound down and crusted over from wet it should be moved, to admit air and warmth more freely to the fibres and roots, which, when done at moderate depth, does not injure the fibres but benefits them; for, if it breaks and tears a few of them up, they shoot out again more numerous all over the ground, taking in food to benefit the plant and to cause it to throw out the burr and the hop. At the latter end of the summer it would be better to have tines instead of hoes in the nidget, or what is called a hop-harrow, having tines more numerous than the hoes in a nidget —it then moves the ground equally well without injuring the fibres. There are some soils of such a tenacious sticking nature as rarely to allow a horse to walk on it without injury in treading and closing the ground. There are several hop-grounds of this description on the gault-clay at the foot of the chalk hills in Kent. On this soil, and others of a somewhat similar description in other parts, it is very rare that a horse can be used for cultivating the ground without treading and closing it so as to be injurious, except in dry weather, in very dry summers; but when it can be done it is right to do it. But there are some planters who prefer hand to horse cultivation even where the ground is well adapted for the latter; and on deep, rich, friable soils, where it all falls to pieces when digging, it is attended with success; but I never saw an instance of it being more successful than horse-cultivation: it is attended with more expense, and it is only on such soils as I have just described but what it would be attended sometimes with bad results. For summer digging, when it breaks up a little nobby at the bottom, in a dry time it lets in the drought, turns the bine yellow, and seriously lessens the crop; but on such stiff, wet, sticky soils, as I have before described, the drought seldom hurts, particularly if care is taken to dig when the ground is not too wet; for it is the nature of these soils, when dug up and become dry with sun and wind, to run like lime with the first little shower; on such soils it must generally be cultivated by hand from necessity, although attended with greater expense. When cultivated entirely by hand-labour the ground will require at least two extra diggings, and from two to four (as the summer may be more or less productive of annual weeds) of extra hoeings —say, twice digging, at 16*s.* per acre each time, 1*l.* 12*s.*; and three times hoeing, at 5*s.* each time, 15*s.*; together, 2*l.* 7*s.* per acre In nidgeting, a horse will go once over 6 acres per day, and continue to do so day after day; and as in triangular plant to

go three ways will do all the ground, 6 acres will be done by a man, a horse, and a boy in 3 days, for which 6*s*. per day would be good pay, which would be 18*s*. for the 6 acres, or 3*s*. per acre, for doing it once. Supposing the ground to be nidgetted 8 times all over during the summer, which is as many times as is ever required, it would be 1*l*. 4*s*. per acre, instead of 2*l*. 7*s*. for hand-cultivation; or, if the plant is square instead of triangular, it would require every time of nidgeting to go four times over, that is, twice in an alley each way; it would consequently cost one-fourth more, which would be 1*l*. 12*s*. per acre.

In horse-culture, as the nidget does not go quite close to the hills, and particularly in square plant with 3 poles to a hill, it is requisite that they should be hand-cultivated around the hills, which is done either by digging with a spud, or chopping with a three-prong or broad hoe, as the nature of the soil may require. The digging will cost from 6*d*. to 8*d*. per 100 hills, or from 6*s*. to 8*s*. per acre; the chopping from 4*d*. to 6*d*. per 100, or 4*s*. to 6*s*. per acre, which expense is not incurred where the ground is dug all over, consequently adding a little more to the cost of horse-cultivation, bringing it all together to 30*s*. per acre for triangular, and 36*s*. for square; the hand-cultivation being, as before stated, 47*s*.

The digging or chopping around hills requires to be done directly the bines are tied to the poles out of the way; for, as in poling and tying the ground is trod down by the polers and tiers, the sooner it is loosened up the better. Digging around is the most effectual, as the ground is moved to a greater depth than by chopping, but care must be taken that it is all broken fine as deep as it is dug, or it will let in the drought; and as on stiff clayey soils that cannot be always done, in that case chopping is best. Digging around the hills is mostly practised in Mid-Kent, and chopping in the Weald and in Sussex. If the ground is in that rough state, which it sometimes is in a dry spring, so that the nidget pulls up the clods and does not break them, they should be broken either by a narrow roller drawn up and down the alleys, or by men or boys with clod-hammers; so desirable it is to have a fine as well as deep tilth, that it should be obtained, however difficult or expensive.

Earthing in the hills is performed with a shovel, with which a small mound of earth is put on the top of the bine between the poles, taking it from the alleys and filling up the space between the poles. This operation is essential for two or three purposes; first, to stop fresh young shoots from coming out of the hills and keep weeds under: it is some support both to the bine and the poles; it causes the bine to enlarge and form cuttings for the next spring; and lastly, it has an effect upon the crop for another

year, inasmuch as where the bine was earthed the preceding year, after they are cut they do not shoot out and come so forward, but are more productive in hop, and branch down more than those that were not earthed, and come forwarder; for as they have nothing but scar bine to cut off, they are not kept back as those that are earthed are; therefore, if it is the wish of the planter to strengthen the stock, he should not earth them; if it is wished to grow as many hops as he can next year, then earth them. Earthing is done from the 8th or 10th to the latter end of June, and sometimes in July, but should be done soon after the hills are cleared; the cost is 3*d.* per 100 hills. After earthing but little requires to be done but to continue nidgeting when the weather permits and it is required, except to keep weeds hoed up that may come around the hills, or at other places where the nidget does not take them. If from wet, followed by dry weather, the ground should be bound down around the hills where the nidget does not take it, then it is a good plan to loosen the ground up with a spud, but not so deep as digging—not to turn it over, pulling the spud up through, letting the earth fall loosely between the spud-spens, breaking it and leaving it fine and level; this will cost 4*d.* or 5*d.* per 100 hills. After the bines are grown out of the reach of the tiers, and before they get to the top of the poles, they will often, from wind or other causes, get their heads so far away from the poles as not to regain them without assistance; they then require ladder-tying, which is done sometimes by men, but generally by women, with a kind of double ladder called a hop-ladder, the back one having only 2 or 3 staves to keep it together, the top staff going through the top ends of both to keep the two together, so as to allow the bottom to open to a distance to stand firm without holding, for a person to go up it when placed near the hill to tie up the head that hangs away from the pole, it standing in this form , the cost of which will average about 1*s.* per acre.

Having gone through all the items of labour up to picking, among which I should have enumerated putting up poles that are blown down with the wind, or that are from any other cause lying on the ground, which, after very high winds, and particularly when laden with bine and hop, will be considerable, it is the practice of many planters at the latter end of the summer to tie them up to the other poles; but the best plan (except in hop-picking, when the hops are ripe and they are just going to be picked) is to pitch a hole, sharpen the pole afresh with a handbill, and stand it in the ground; it gives the hops a better chance of growing out and ripening. As this is a casualty, it depends much on circumstances what the cost may be; I should say 5*s.* per acre, taking the average of years.

### *Manures and Methods of Manuring.*

As the annual produce, both in bine and hops, is great, the ground requires at least an annual dressing of manure, and sometimes twice in a year. The hop, being a perennial plant, has not the advantage of being benefited by a rotation of crops, as wheat or barley with alternate green crops—the roots and refuse of one being food for the other; but here is, year after year, so long as the ground is continued in plant, a requirement of the same description of food for the plant.

There are various descriptions of manures which experience has taught us to be well adapted to the necessities of the hop-plant; and we also learn from the same source that some that are well adapted for one soil are not equally so for another; and we find there is no manure better adapted for every variety of soils than good farm-yard dung, and particularly when beasts have been fed on it with oil-cake or corn; and why this is so, we are told by those who are versed in agricultural chemistry, is, because that manure most contains all the varieties of substances that the plant requires, and in a more equal degree than any other. Mr. Nesbit, in his analysis of the mineral ingredients of the hop, published in vol. vii. part i. of the Society's Journal, has made it appear that one sort of manure, with a much less quantity of it than is usually put on, contains a sufficient quantity of some ingredients, and not enough of some, and scarce any of others, that are required by the hop-plant; showing that very few of the various manures, however abundantly laid on the ground, are sufficient for its healthy subsistence without the help of others, and that an unnecessary expense is incurred in laying on more of one description of manure than is useful, and that manures should be mixed. The correctness of all this I do not doubt, and a change of manures every time the hop-ground is manured I have found by experience to be good, constituting a mixture of manures in the earth; for it cannot be, because I lay on a manure that contains a double quantity of one ingredient required by the plant, that, as the plant only takes half that year, the other half will be of no use another year.

I have no doubt that a more judicious application of manures to hop-grounds, as well as to the other products of the earth, may and will be effected with the help of science; and that if not brought to a higher state of perfection than some are now, the same state will be attained with less expense.

The principal manures used for hop-grounds are farm-yard and oilcake-fed dung, woollen rags, shoddy or wool-waste, seal-skin, rape-cake ground down to a powder, guano, &c.; the two latter named are better and more applicable for summer manuring. Sprats are often used for manuring hop-grounds; they act

quick, but do not last long; and as they can only be obtained in the early part of the year, they are more applicable for bine than hops. Woollen rags are a lasting manure, but are more useful and decay sooner on dry than wet soils; shoddy and seal-skin are more active manures than woollen rags, but not so lasting, but, like them, better adapted to dry soils than wet or stiff strong soils—all those three manures are better adapted for the Kent rag than any other soil I know of.

The general time of manuring is previous to digging in winter or spring, and every opportunity should be taken of a frost to cart out heavy manures, as farm-yard dung, or good fresh vegetable mould where it can be obtained from any old hedge-rows or other places, and requires a frost to cart it, as it should be laid thick—from 80 to 100 one-horse cart loads to an acre; or, if farm-yard dung, from beasts fed with cake well made and moderately heated, from 20 to 25 yards cube per acre; if inferior dung, more; if dung and mould mixed before carting, from 60 to 80 one-horse cart loads per acre; woollen rags from 12 to 20 cwt. per acre—average cost of good rags, with cutting and carriage home, 6*l.* per ton; shoddy to be put on at the rate of 20 to 30 cwt. per acre, cost about 4*l.* per ton. Seal-skin is generally sold by measure, about 7½*d.* per bushel; about 160 bushels is a dressing for an acre. It is difficult to ascertain the cost of farm-yard fatting dung, but it is, when meat sells at a low price, obtained at a very great expense, often costing the planter 10*l.* per acre for every acre of hop-ground he manures with it. I have stated above, that the winter or spring previous to digging is the most general time for putting manure on hops, but any of the before-mentioned may be applied as a summer dressing except mould, which, from the quantity required, would be expensive to get on the ground; but dung is often wheeled in with a barrow to a distance of 40 or 50 hills at a cost for wheeling of about 6*d.* to 8*d.* per 100 hills wheeling in and spreading; if summer, dug in; but the more general and less expensive method is to open a trench around the hill, put in the manure and tread it in, which may be done, wheeling in dung included, at 1*s.* 6*d.* per 100 hills; if with rags or other light manures, at 1*s.* per 100. This summer manuring may be commenced as soon as the hops are tied up out of the way, and should be finished before midsummer, when the fibres begin to run out from the hills.

Guano and rape-cake dust are a very good and convenient manure for summer, and may be put around the hills as above, or spread broadcast over the ground and nidgeted in. In the year 1844, which was a dry summer, I manured a piece of hop-ground, putting it around the hills as before described, every alternate five rows of hills with guano and rape-cake dust, each

at a cost, including labour and carriage, of 4*l*. per acre, leaving 3 rows across the ground, at three different places, without either; it was put on the 1st and 2nd of June. From that time until hop-picking I could not perceive any difference at any part of the ground (which was only 3 acres) between the rows manured with guano and those with rape-dust; but there was soon a visible difference between the 3 rows not manured and those that were; and the result was, that 3 cwt. of hops per acre more was grown on those manured than the average weight per acre grown on the three rows not manured. This ground was all winter-manured: the crop grown through the piece was 13 cwt. per acre; on the 3 rows not summer-manured, at the rate of 10 cwt. per acre. I did some about the 20th of June in the same year, but the result was not so favourable, although there was a perceivable benefit. If guano or rape-cake is laid on the latter end of June or beginning of July, it is better to spread it all over the ground, that the young fibres may act upon it. I have before stated that stale-ploughed arable land should be manured for hops before ploughing or trenching, but that lime on fresh-ploughed-up meadow or pasture, laid on in the summer or autumn after planting, would be best. Lime may occasionally be used with great advantage on some soils—on old planted ground, at the rate of 200 to 250 bushels per acre.

## *Diseases of the Hop.*

Having gone at some considerable length into the modes of planting, cultivating, and manuring, I will now proceed to give a brief account of some of the diseases to which the hop is liable; but to give a full account of the nature and origin of some of them would form an Essay of itself, and one has already been the subject of an Essay for a prize given by a member of the Society. I presume it is not expected of the writer of this Essay to give a full account of the nature and cause of these various diseases and the remedies—that coming more under the department of the scientific than the practical man: I shall merely state what I know practically of them. The hop-set is no sooner put in the ground than its enemies find it out. The *Wireworm* attacks the young plants and destroys many of them, and particularly on ploughed-up meadow and pasture; nor are its depredations confined to the first year of planting, for they will renew their attacks the second summer, and continue to do so until the plant is too strong to be much injured by them. The best remedy is to plant a potato, divided into two, near each hill, and take them up every day, pick out the wire-worm, destroy them, and put the potato in again for more, for they will leave the hop-sets for potatoes. Every assistance should be given to the plants by

manure and cultivation to bear the attacks and grow away from the wire-worm.

The *Flea*, a similar insect to that which attacks the young turnips directly they come up, and often destroys the crop, locally called the flea, fly, or turnip-beetle.—As soon as the young shoots of the hop-plant appear above ground this insect commences its attack upon them, eating the young leaves and heads, stopping the growth, and often quite destroying the young shoots; it is most prevalent when the weather is dry and rather cold, with frosty nights and sunshiny days; and when the ground lies a little rough and cloddy; they find a shelter under the clods, and do more injury than when the ground is fine about the plant. It is a good plan to make the ground fine around the hills, and sift some dust on the top of them. In warm, dull, showery weather the young shoots are not so strongly attacked, and they grow faster out of the way of the flea; and when the bine reaches the pole, although the insect follows them, perforating the leaves, it is not often that much injury is sustained; but when they continue their attacks on the young shoots from day to day, and, as they often do, from week to week, it is often a serious injury, keeping the bine back until too late for recovery; and what does get away is very unkindly, and being backward often becomes an easy prey to its worse enemy the hop-fly. When the young bine is thus strongly attacked by the flea, and the shoots become wiry and stunted, it is better to cut all off the stock, hill it up again, and leave them to make fresh shoots, which will come away more healthy, and, although backward, if they meet with no farther obstruction, may grow 2-3rds or 3-4ths of a crop. I have seen great benefit from catching the flea, which is difficult to do when the shoots first come up; but when 6 or more inches long it is done more effectually than many would imagine with a common tin funnel put into the nose of a common black wine-bottle, and with a small hair brush or goose-wing brush them into the funnel, which should be held close to the bine; they will slip down the funnel into the bottle, where they cannot jump out; a great many will be caught, and others will jump away. This should be repeated daily, for even disturbing them does good. These insects remain in some way or other with the plant, as the leaves are seen perforated by them up the poles, and they are often found in the hop, doing considerable injury.

*The Hop Aphis.*—No sooner has the young bine got away from the flea than it is attacked by a more formidable foe, the long-wing, or hop-fly, which generally make their appearance about the middle and latter end of May, about the time the bine is from 4 to 6 feet up the poles; first, on the underside of the small leaves next the head of the bine. There is not a year but

what some appear; in some years they shortly disappear, leaving but few of their progeny behind, and no injury is sustained by them; whereas in other years the young leaves, in the course of a week or two after their first appearance, are quite filled with them, leaving lice and nits on every leaf, subsisting on the juices and sap of the plant, which for a time, if growing weather, continues to flourish. After a while the flies that have blackened the leaves with their numbers begin gradually to die and disappear, a few fresh ones appear to come, and in their turn die, but leave behind them a numerous progeny of lice and nits, which continue to increase after every fly is gone, until every leaf is filled with them, when they begin to crawl on the bine up to the head, extracting every particle of juice, shedding their excrements, which, mixing with the juices of the bine and the morning dew, and falling on the leaves below, form that shining sticky moisture called honeydew. The head at length, from want of sap, droops and apparently dies; the lice by this time, having gone through their various stages, for want of moisture in the bine, die also; the leaves with the honeydew dry up and turn a rusty black, and after a while drop off; and but few, if any, of the bines recover to produce hops; and all this is done in 6 or 8 weeks: this is what I would term a rapid blight. When the fly is not so numerous at the first, or the weather cold and not so congenial to their increase, the blight will be slower, but not the less fatal; sometimes the planter is buoyed up by appearances until the last. There is sometimes when in burr an appearance of a tolerable crop—then their strength fails—they can do no more, and the produce is worthless. There are instances of great recoveries from blight, as in 1807, 1834, and, in some parts, in 1846, when the weather and every other circumstance was favourable. Various methods have at times been tried, both as preventives and cures, but not one that I ever saw could be depended on. High manuring and good cultivation will assist a recovery; but it will sometimes, from producing more sap, cause the aphis to continue longer, and consequently less time is left for recovery. A hop-ground that has been blighted with the Aphis one year is never blighted with it the next; I never knew a single instance of it. These aphides have their enemies in the fly-golding, or ladybird, and its progeny the neger, which have done more in preventing a blight than any human means could ever do. It would be unnecessary for me to say anything more, if I could, than what in my practice has come under my observation as a hop-planter. But why Mr. Lance, in his 'Hop Farmer,' calls it a barometer of poverty, I am at a loss to guess; as the most highly managed and fertile hop-grounds are as much subject to it as the worst.

### *Mould.*

This is a disease more mysterious than any I have named, the origin and history of which would, in the hands of a person acquainted with it, I have no doubt, like the hop-fly, form an essay of itself. What I practically know of it is, that it is a more partial disease than the aphis blight, for a ground may be so blighted with the mould as not to grow a single hop worth picking, and another within half a mile of it may grow a full crop of hops. The aphis blight generally spreads over considerable districts, and sometimes nearly all over the kingdom the same year. The mould is always most prevalent in moist and warm summers, and more peculiar to some varieties of hops than others. The Goldings are more subject to it than the Grape; and some soils are more subject to it, Mid-Kent more than the Weald or Sussex. It is a much greater blighter of the planter's prospects where it falls than the aphis, for in the latter, if the crop he grows is less, it is in some degree made up by the greater price he gets for what he does grow : not so with mould; the effects of that, being generally partial, are seldom so extensive as to affect the price. The disease is in some degree contagious, and may be wafted with the wind from one ground to an adjoining one; some attribute it to high manuring, others to certain descriptions of manures, but I have seen grounds quite the reverse very mouldy.

### *Hop Picking.*

Having gone through the system of management, &c., from the commencement of planting up to the time of picking, although some things of minor importance may have escaped my notice, I have endeavoured not to omit anything that might be useful to those who are uninitiated in the culture and management of hops. I will now, with the same view, as briefly as the subject will admit, proceed to detail the system of management after the hops are grown. As soon as the hops are ripe, and will, as it is termed, stand the fire, which is ascertained by the closing up and firmness of the hop, when the seed becomes firm and the outside of it brown, and the general appearance indicates ripeness, picking should commence. Every planter should be careful to secure as many of the strangers who annually flock to the hop-districts for picking as he may require, over and above the number of residents he may have engaged, suiting the number altogether to his crop and convenience for drying, calculating not to exceed a month in picking, for, although he may have the early and backward varieties, a month at all times will be quite long enough, and if it can be done in three weeks it would be desirable, for if hops are picked before

they are ripe there will be a deficiency both of weight and quality, and if they hang too long they will get brown and part blown away by winds; it is the middle picking when the best quality is obtained; and although the colour may not be so even and green as the first pickings, they show a richness the others do not. The time for picking will vary as the summer may be backward or forward: somewhere from the beginning to the middle of September, or from the 6th to the 15th, is the most usual time; I have known it commence in August and sometimes late in September; I allude to a general commencement, not to here or there a particular ground, or to a planter who has an ambition (if I may so use the expression) to have the first pocket of hops in the Borough market. It appears almost unnecessary, as the mode of picking hops is so well known, to go into any minute detail upon it, but, as there are some arrangements relating to it better than others, I will endeavour to state them. Hops are either picked in large baskets, or in bins, the latter being the most general one, the bin-frames being sufficiently large to take a cloth for two persons, or a family of a woman and two or three children, to pick in; a man to pull poles to every four or five of these bins, to what is called a bin's company, consisting of eight or ten full-grown pickers, or of such a number of children as may be equal thereto; the pole-puller, or bin-man, as he is called, in addition to his labour of pulling poles, to hold up the bag or poke for the man who measures to put the green hops in, to carry them to the waggon or cart that takes them away to the oast, and to strip the bine off the poles after the hops are picked off from all he pulls, for the sooner the bine is taken off the poles the better, since when lying in lumps in wet weather they are more liable to be injured, as the bines hold the wet. The bin-man, with his pickers, is placed to a certain number of hills, which is called a set, remains with them there until it is all picked, and then they move all together to another set; 100 hills generally are put to a set, which afterwards form a stack of poles. These arrangements, although perhaps of minor importance, tend to prevent confusion and promote regularity among the pickers, particularly when there are a great many. Hops are picked by the bushel, and are measured in a basket holding about 10 gallons imperial measure; the basket should be lightly filled level with the rim; the price given per bushel varies with the crop, from 3 or 4 bushels for a shilling up to 9 or 10 in good crops; they should be picked free from leaves, with the exception of a few small ones, and not in bunches. Hops are much cleaner picked than they used to be forty years back; at that time one penny per bushel was a common price for a good crop. At Farnham they are picked in a superior manner to any other district, being picked quite separate, free from leaves,

and the inferior and discoloured hops sorted out and put by themselves, which in some degree accounts for the superiority and higher price of Farnham hops; but since the Mid and East Kent Golding hops have been better picked and dried, they have approached nearer to the price of Farnhams, and there has been an instance of hops grown in Kent making more money than any Farnham hops did the same year.

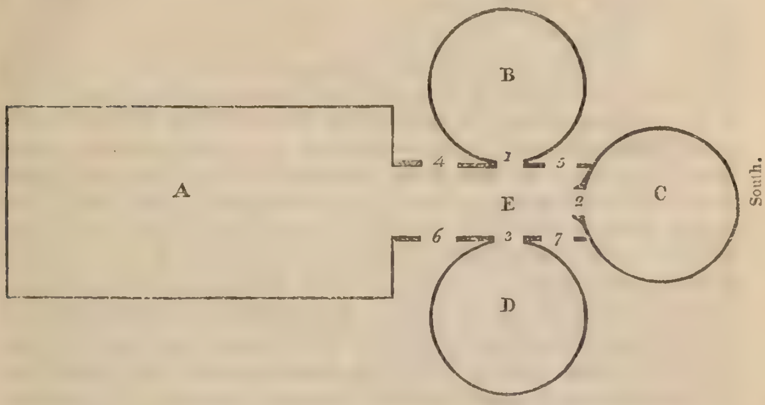
*Drying.*—In no department of hop management has there been a greater improvement of late years than in this; and the great improvement that has within the last thirty years been made in the drying-kilns or oasts is the principal cause of it. Both growers and consumers are indebted to the late Mr. John Read, of Regent's Circus, for the invention of the circular kilns, which have at different times been improved, and are becoming every year more general throughout Kent and Sussex, and are now brought to that perfection that double the quantity of hops are dried on the same space and in a superior manner. It is not altogether the form of the kiln, or oast, that constitutes the difference, although I believe the circular to be the best; but it is the distance of the hair from the fire, the great distance of the cowl or ventilator above the hair, the uprightness of the cone above, the length and circumference of the cowl, and the free circulation of air from below passing through the hops, driving the moisture from the hop up with it through the cowl, that constitutes the great improvement. Formerly, on old kilns, half a bushel of hops on a superficial foot of hair was considered to be and was as much as could be dried at one time without injuring them or getting behind; for as the custom is to load the kilns twice in twenty-four hours, it is necessary that hops picked one day should be all dried and off the kilns by the middle of the next day, when the first load from the grounds will be brought in, which, when the kilns have a greater quantity of hops than they can dry, or as the term is overloaded, cannot be always done; it is therefore of very great consequence that the quantity of hops should be suited to the capabilities of the kiln. In the old plan of building oasts, the distance of the hair above the fire seldom exceeded 7 feet, and sometimes not so much: air was not permitted to pass through the fire so freely, nor could it be allowed to do, for, from the nearness of the hair to the fire, and the roof of the building coming on above much nearer the hair than in the modern kilns, too great a circulation of air would have caused the fires to burn so fast as to injure the hops and drive the moisture off them faster than the roof and form of the building would admit of its getting away. It would, some of it, drop back on the hops, and discolour them; it was these and other deficiencies in the structure of the building that would not permit of more hops being dried at a time than I have mentioned;

but when that quantity was not exceeded, or often a considerably less quantity was put on, and under the management of a skilful drier, very good samples were and still are produced from such kilns. But on the improved circular kiln, which is generally from 10 to 11 feet from the fire, varying a little with the area of the circle, the height of the cone being from 18 to 20 feet above the hair, with a cowl of 7 or 8 feet high and of 3 or 4 feet diameter at the bottom, a free circulation of air through the fires from the bottom of the kiln, which, becoming heated and rarefied, passes through the hops, driving the moisture up the cone and out of the cowl before it, a *bushel* of hops each time to a superficial foot of hair may be dried in the same *time*, and nearly at the same *expense* for fuel, as *half* a bushel on those I have before described.

All hop-planters agree as to the principle of passing a great quantity of heated air through the hops, to drive off the moisture without an excess of heat, and that the circular kilns, as before described, are the best adapted for that purpose; but various are the opinions and as various are the different modes adopted for the admission of air; some contending that all the air should pass through the fireplace, some that it should be let in at different places around the circle, to mix with and become of the same temperature as what passes through the fire before it goes through the hops; others have only one fireplace underneath a hair of 16 or 18 feet diameter, the cold air, coming in at the entrance or at other places, mixing with the rarefied air within. Some kilns are fitted up with cockles (that is, a large iron furnace), with flues around the inside of the circle close to the wall to heat the space within. The cockles (as the smoke does not pass through the hops, but is carried off by a chimney) admit of burning the common household coals, or wood, if required; whereas, the others—which, by way of distinction, are called open fires—require either Welsh coals, coke, or charcoal—fuel which has no smoke, as the least smoke going to the hops would give them a smoky smell and injure them. The open fires are more generally used than the cockles, as they dry the hops quite as well, and nearly, or quite, at as little expense, and the original cost of erection is much less. Mr. Knight, iron-founder, of Maidstone, has within a few years invented a cockle upon a different principle, which is well spoken of, and does its work very well. All these different modes are found to answer, and dry good samples of hops; and as the main principle of all is the same (viz. passing as much heated air through the hops to dry them as may be necessary), it is perhaps a matter of fancy as well as judgment which is the best. Again: there are different plans of placing the fires in these circular kilns; some, as I before observed, having but one fire near the middle, open

to the space within; others two or three fires, placed at regular distances in the same way; some are with an arch 6 feet high and 3 wide, extending two-thirds of the way across the circle, with a fireplace at each side and one at the end; others have only one fire at the end of the arch, and then the arch should extend only about one-third across the circle. There is also what is called the inner circle, which is a second circle built within the other with brick, to about the height of $3\frac{1}{2}$ to 4 feet, leaving a clear space of 3 feet or more between the inner and outer circles; the former above the brickwork being quartered and plastered, leaning out all around, reaching the outer wall just under the hair, forming as it were a hopper around the upright brickwork: the fireplaces are made round the outside of the inner circle, two, three, or four, as may be thought best, but three is most general; the only entrance to the hopper being a small hole sufficient for a man to get out and in to clean it out, which is closed when the hops are drying; the air here enters through holes around the bottom of the outer circle and through the fires of the inner one, when it becomes heated and passes through the hops. The inner circle is a somewhat more expensive building; and although it is a very good plan, I do not know that it is better than the arch or those that are open to the space within. It will be well here to state that where there is only one fire it is quite requisite to have a broad iron plate, either suspended or resting on open brickwork over the fire, to keep the heat spread, and to prevent the fire being too fierce to that part of the hair immediately above it; for, as there is but one fire to a circle of 16 or 18 feet diameter, which will take 200 or 250 bushels of hops at a time, it must of necessity be a large one to dry them. It is a very good precaution, although not so absolutely necessary, to have horses or hogs (as these plates, resting upon open brickwork, are called) over the fires, when there are three to the same space: it is a safeguard, and can do no harm; the plate should be at a distance of 2 or 3 feet from the fire. Of all the foregoing plans I am not able to say which is the best; but that neither of them will succeed equally well in all places and at all times I can assert; there is a great deal depending on the local situation of the oast-house with regard to other buildings, trees, hedges, banks, or anything that may obstruct a free circulation of air when the wind is at any particular point, and even as relates to the situation of the oasts or kilns themselves in respect to each other. If a new oasthouse is to be built, it should be placed to avoid having any thing to obstruct a free circulation of air around it, but not in a too open or exposed situation; and with respect to the situations of the kilns with regard to each other, and to the stowage or cooling-rooms, the plan following—of which I know of two or three

oasthouses, and four years since have had one built for me on the same plan—dries the hops very even and well.




The above plan is on a scale of 20 feet to an inch, and is laid down here to show how the kilns may be situated in regard to each other, so as to assist and not impede a regular circulation of air to either.

A is a room under the stowage or cooling-room, 40 feet long by 20 feet wide, which might be larger or less, as might be required, and used for stowing and weighing hops in picking-time; it might be open on one side to be used as a cart and waggon lodge, or enclosed for any other purpose, having doors or windows where required; the stowage for cooling hops above would be of the same dimensions.

B, C, and D are ground-plans of three circular kilns, in which may be placed any of the before-mentioned descriptions of fires, either open or cockles.

E, a passage 8 feet wide.

1, 2, and 3, openings for entrance of persons, and also for admission of air into the space within the circle, either through the fires or not, as before described.

4, 5, 6, and 7 are outer doors, opening into the passage E, for the admission of air; and here it may be observed that neither of the doors opens directly on the opening either of 1, 2, or 3, so as to cause too fierce a rush of air or the wind to blow directly to the fires, but to keep a constant supply of cold air in the passage to flow regularly in the opening 1, 2, and 3. Only two out of the four doors would or should be open at the same time, or the current of air coming in at one door would pass out at the opposite one; and should the wind blow hard, either from east or

west, so as to drive the fires too fast, by shutting those doors there would be a sufficient draught of air come in at the other doors; for whichever way the wind may be, the air will draw in, at either of the doors that are open, flowing around the outside of the circular walls. The circles here shown are 16 feet diameter, the nearest outside distance of the kilns to each other is 4 feet; the hairs above are, of course, of the same dimensions as the circle below, with a passage to put the dried hops from off the kilns, which, from the distance the hairs require to be above the fire, would raise them 2 or 3 feet above the level of the passage, which would be even with the floor of the stowage. At one of the angles between the kilns a door is placed opening to the upper passage, with a step-ladder to carry the green hops to lay on the hair, to which there is an ascent from the passage by short step-ladders, moveable at pleasure. An oasthouse, of the plan and dimensions here shown, will dry 1200 bushels per day, 200 on each kiln twice a-day; if 18 feet diameter, each kiln would dry 250 bushels at a time, or 1500 bushels per day: if only two kilns are required, the end one could be left out; or if more is wanted, it could be done by having a longer passage, and two on each side and one at the end, on the same principle.

I have endeavoured to show the superiority of the circular kilns and the best method of placing them, and that, although more hops may be dried, and better, much still remains with the hop-drier; for on whatever description of kilns they are dried, they may, from want of skill and judgment and attention in the drier, be spoilt either by being burnt, scalded, or underdone; but, to the credit of most of them, I may say neither is often the case. There is a praiseworthy ambition amongst hop-driers to endeavour to excel each other, and emulation is excited by most Agricultural Societies in the hop districts giving premiums to the best hop-driers.

At the beginning of hop-picking, when the hops are scarcely ripe, more care is required that the fire does not take too much hold of them, as they do not take the fire so well as when riper; for hops when burnt or having the least smell of fire are much deteriorated in value. Caution should be given to the drier as to the application of the sulphur, which is a great assistance to the drying as well as to the colour and appearance of the hops; it should not be put on too much at a time, but should be begun soon after the hops are laid on, and continued gradually and slowly burning for four or five hours: the quantity to be used depends on the state of the hops; more requires to be used when the hops get brown than at first, and the quantity is varied from ¼ cwt. to a cwt. to a ton of hops, the cost of which is about 11*s*. or 12*s*. per cwt.; if Welsh coal or coke is used, about 13 cwt.

of the former or a chaldron of the latter with a little charcoal will dry a ton of hops, at a cost of about 25*s*. per ton, or 1*s*. 3*d*. per cwt. When the hops are dried sufficiently, which is ascertained by the feel more than appearance, they should be taken off the hair; for if they are allowed to remain ten minutes or a quarter of an hour too long they will be overdried, and become too brittle, harsh, and difficult to get cool; they want narrowly watching and taking at the right time. It is better that there should be here and there a tough hop than that they should be too much dried; for by letting them lie two or three hours in a lump after they come off, those tough hops will become more dry, and when the hops are sifted it will take all tough ones out: but there has of late years been an objection to sifting, as it breaks the hops too much, the merchants preferring them whole and flakey; there is consequently a little more difficulty in getting them quite right than when the general custom was to sift, which was the case until within the last ten or twelve years; for the two extremes require to be avoided, they must be neither underdone or overdone: when overdone it breaks them to pieces too much, and they are not so saleable; not that the hop sustains any particular injury by being done a little more than necessary, as it is requisite they should be well done, or they will not keep. Therefore, when I state that it is better to take them off with a few tough hops than to overdry them, it is with the supposition that those tough hops become done whilst lying in a lump, or are taken out with the hop-sieve or otherwise; for it is a much worse fault to pack them under than over-dried; for if hops are not dried they will not keep, and consequently it is difficult to meet with purchasers, unless for a lower price for present use. If the hops are not sifted, it is a good plan to throw them up in a round lump; and as the large and tough hops will roll down to the outsides of the lump, they can be put on one side and laid for a little while on the hair again. It is not from lying a little while longer than they ought that hops acquire that peculiar smell of the fire which some have. This is an injury done in the early stage of drying, by having too hot a fire at first, or too fierce an application of burning sulphur, either of which is considered bad management on the part of the drier, and is sometimes caused by loading the kilns too hard before the hops are quite ripe; but it is the fault of many driers—fearing they shall not get them off in time—to give them too much fire at first. On a good oast they may be driven a little at last, but must not be hurried at first.

Packing or bagging should be done as soon as the hops are sufficiently cool to press well under the feet without breaking to pieces, or what is termed mudging. To get them cool they should be spread as thin as possible over the cooling-floor, and

which is best done by keeping them packed up close after drying: for when the dried hops are allowed to accumulate in the floor, they are obliged to be laid thicker, and it is then with great difficulty they are got sufficiently cool to tread without mudging. Some planters that I know make it a rule to get one oasting trod up before the next comes off the hair, having all the room for each oasting to cool in. They should, if possible, unless there is a great quantity of cooling-room, be trod up, at the longest, the first oasting before the third comes off, and so to continue. If a planter has a wish to mix a quantity of hops, and has a roomy stowage or cooling-room, or any other place where the hops will lie dry and not much exposed to the air, he may keep them until he has done or got the quantity he wished to mix, and then turn them up together and tread them, having a few spread abroad near the bagging-hole to cool as they tread them. If hops get too cool, and particularly when scarcely dried enough, they become clammy, will go well under the feet of the treader, but there is no rise or spring in them: such are not so saleable. Those generally come best in the sample, both to the smell and touch, that are got cool and trod up soon after they are dried as above described. The most general method of packing hops—and the only one, until within the last few years—is to tread them with the feet; a hole is generally made at one end of the cooling-floor, and with a frame and curb raised about a foot above the level of the floor; a round hoop being first fastened in at the top of the bag, it is let down in the hole, the hoop resting on the curb—it being a little larger all around, it cannot slip through. The bag is thus slung from the ground, when a man gets in and treads them, a boy putting them in with a basket or large scuppet, and when it is full the hops are sewed in with large twine, which is called coping up; the bag is then let down to the floor below by taking away the lever with which it had been raised above the curb for coping. Hops are packed either in bags or pockets, as the planter may consider best; the brownest and strongest hops are generally put in bags, the finest coloured and first pickings generally in pockets; but there are several Mid-Kent planters who universally put all their hops in bags, many or most of which consist of the Golding variety: such are mostly bought by the same merchants and used by the same brewers every year. There are not so many bags packed annually, in proportion to the growth, as there was thirty or forty years, or even twenty years back; for although they keep best in bags, the weight of the package is much more in proportion to the weight of hops it contains than it is in pockets, which is one reason they are not generally so saleable, and consequently not so many packed.

The weight of baging as allowed by law is 1 lb. to every 10 lbs.

gross weight, so that a bag of hops that weighs 2 cwt. 2 qrs., or 280 lbs. gross, is allowed to have baging of the weight of 28 lbs., leaving only 252 lbs., or 2 cwt. 1 qr. nett weight, which is about equal to the weight contained in a pocket and a half, of 1 cwt. 2 qrs. nett, which with the weight of a pocket, 5 yards of cloth at 1 lb. per yard, the general weight, would be 5 lb. tare, making the

| | Cwt. | qr. | lb. | | Cwt. | qr. | lb. |
|---|---|---|---|---|---|---|---|
| Gross weight of a Pocket . . | 1 | 2 | 5 | Total gross weight in Pockets | 2 | 1 | 7½ |
| ,, half a Pocket | 0 | 3 | 2½ | | | | |

which if put in a bag would be 2 cwt. 2 qrs., or 20½ lbs. more in every bag than if the same were put in pockets, which supposing hops to be worth 1*s.* per lb. would be 20*s.* 6*d.* (supposing they sold at the same price) more for the same quantity of hops in every bag than if put in pockets, which is a difference of 8*s.* per cwt. in favour of bags, so that 5*l.* 4*s.* per cwt. in bags is equal to 5*l.* 12*s.* in pockets, supposing the hops to be of equal value in each; this is the actual difference to the consumer, and in the same proportion as the price may be more or less. But the planter would be a loser by selling his bags at 8*s.* per cwt. less than his pockets as above stated, inasmuch as he would have more duty to pay for the bag than for the same nett weight in pockets, for both in bags and pockets 1 lb. in 10 is deducted from the gross weight before the duty is charged: it would be as follows:—

| | Cwt. | qr. | lbs. | lbs. | lbs. | | £. | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| 1 Bag of Hops . | 2 | 2 | 0 | or 280 gross, | 252 | nett, at 2*d.* per lb. | 2 | 2 | 0 |
| 1½ Pockets . . | 2 | 1 | 7½ | or 259½ ,, | 233½ | ,, ,, . . | 1 | 18 | 9 |
| Difference . . . . . . . . . . . . | | | | | | | 0 | 3 | 3 |

Showing that the planter will have 3*s.* 3*d.* more to pay duty for one bag of hops than if the same hops were put in pockets, which is about 1*s.* 4*d.* per cwt.; so that when hops are worth as above calculated, on 5*l.* 12*s.* per cwt. he must, to make the price equal to him, obtain within 6*s.* 8*d.* per cwt. instead of 8*s.*, which would be 5*l.* 5*s.* 4*d.* per cwt. in bags, instead of 5*l.* 4*s.* as before stated.

The above calculations are stated to show that the actual difference of the value is more to the consumer than it is to the grower between the price of bags and pockets, which is no doubt one reason why there are not so many bags put up as formerly; and it also appears that the planters pay 1*s.* 4*d.* per cwt., 1*l.* 6*s.* 8*d.* per ton, making, with the addition of 5 per cent., 1*l.* 8*s.* per ton more duty on the same hops in bags than he would if they were put into pockets.

Hops should bring to the planter in bags 17-18ths of whatever the price may be in pockets, to make it equal to him.

The new mode of pressing hops with a machine was invented by the late Mr. Ellis, of Barming, and is now adopted by several

planters ; it has but one advantage over the old method of treading, which is that hops may be pressed warmer than they can be trod, without breaking or mudging them ; but they do not draw so well in the sample, or look so well, as those trod in good order with the feet ; there is neither a saving of time nor expense to set against the cost of the machine, and as the disadvantages are equal to the advantages, it is not likely to become very general.

After the hops are packed and weighed by the Excise they may, after remaining 12 hours, be removed for sale, or where the planter chooses. It is unnecessary to state here what is so well known to every one at all connected with the management of hops, the regulations of the Excise as to giving notices for baging, &c., as this forms no part either of cultivation or management, and of which should any young planter be unacquainted, he may soon get information. But there is one observation I should have stated when making the comparison as to the relative price of bags and pockets, that the cloth to pack them in costs about the same ; a pocket of hops requires 5 yards of cloth at 7*d.*, and 1*d.* for making is 3*s.* ; putting the baging at 18*s.* per cwt., which is about an average price, a bag which weighs ¼ of a cwt. will be 4*s.* 6*d.*, which containing the same weight of hops (as before shown) as there is in a pocket and a half, makes the price for the cloth for the same weight exactly equal ; and although it may vary a little sometimes either one way or the other, there is no difference to calculate on or interfere with the statement I have before made on that subject.

Before I close this Essay I must return again to the hop-ground to state a process which has not yet been under our consideration, which is, Stacking the Poles. The sooner the poles are got from the ground the better, as they receive much more injury lying on the ground from wet than when stacked up, and particularly where they have not been stripped by the pole-pullers ; and if the planter has labourers to spare, it should be done as close after the pickers as it can be done. The general practice is to put them in conical stacks, the sharped ends on the ground, the tips leaning against and supporting each other ; when the plant is square, they must be put up in 4 legs striding, one row with a hill right under the tips of the poles or centre of the stack ; the triangular plant should be set up with 6 legs, each leg in one of the six spaces around the centre hill, that being perpendicularly under the tip of the stack as in the square work. Here again is another advantage in triangular plant ; 6 legs will stand firmer than 4, and as there are less poles in each leg, they will stand clearer from the hills, for it is necessary that every hill should stand clear from the poles, that they may be dug and cut.

At the time of stacking the refuse poles should be thrown out and bound in bundles with bines, separating those which are

fit to put up to young hops, or to grounds requiring less poles than those from which they were taken, from those poles only fit to burn either for charcoal or any other purpose. Each quarter or leg of the stack should be bound around about two-fifths of the way up with 3 bines, with all the leaves stripped off them, and well twisted together; it keeps the poles close and compact together, and may prevent some from being stolen, or, at any rate, it is much easier to discover if they have been interrupted than if not bound.

It will here be in proper place to make a few observations on poles that have not as yet come under our notice. I have, in stating the varieties of hops and the capabilities of different soils, stated the lengths and size of poles best adapted to them. I will now give a short description of the different sorts and their relative value. Where large poles are used there are none that will stand longer than chesnut, for where they have a considerable size of heart, they will stand for many years after the sap is rot off just above the ground, and are tougher than heart of oak; but in a smaller sized pole, as the heart is smaller, they are not of more value than the other better description of the better sorts, such as ash, willow, and maple. Larch firs have been planted close for hop-poles, and have come into use considerably lately; they are very straight and handsome, and are said to be very lasting. I have only used them for four years; but from what I have seen of them they will stand foremost up to a 14 feet, and then will yield superiority only to the chesnut; there are some sorts of wood—for instance, yew or box—that would, perhaps, last longer than either, but as these are not applicable to any extent for that purpose, it is useless to say anything further respecting them. The inferior sorts of wood generally cut for poles are oak, birch, beech, hazel, white birch, and alder; the two last named are very inferior. It is of more consequence in large poles as to the sort of wood than in small poles, but it is of some consequence in all; but as the poles of 14 feet long and upwards will, when they have lost one or two sharps, do to go into a ground where only 12-feet poles are required, and as it is more the nature of the best wood to break only just above the ground, they will continue to wear down without breaking and falling to pieces in the middle as the inferior sorts do, they are capable of being used down to the shortest length required, or that will do; but with 12-feet and 10-feet poles that is not of so much consequence, for when they have lost a sharp they are only fit for weaker binded grounds or young hops. I shall perhaps best show their relative value by giving a statement of the prices of each, but as that much depends whether they are of young or older growth (for poles of 14 or 15 years' growth will last much longer than those of 8 or 10 years), or whether they are cut pro-

perly and well, but more particularly on the supply and demand. I will therefore state as near as I can the average prices for well-cut poles of a growth from 12 to 14 years:—

| | 18 feet Poles. | | | 16 feet Poles. | | | 14 feet Poles. | | | 12 feet Poles. | | | 10 feet Poles. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £. | s. | d. | £. | s. | d. | £. | s. | d. | £. | s. | d. | £. | s. | d. |
| Chesnut . . . . . . | 2 | 8 | 0 | 2 | 0 | 0 | 1 | 10 | 0 | 1 | 0 | 0 | 0 | 8 | 0 |
| Larch . . . . . . | 2 | 5 | 0 | 2 | 0 | 0 | 1 | 14 | 0 | 1 | 2 | 0 | 0 | 10 | 0 |
| Ash, willow, and maple | 2 | 0 | 0 | 1 | 14 | 0 | 1 | 8 | 0 | | .. | | | .. | |
| Oak, birch, beech, &c. . | 1 | 10 | 0 | 1 | 6 | 0 | 1 | 0 | 0 | | .. | | | .. | |
| Mixed ash, willow, &c., with oak, birch, beech, &c. . . . . . | 1 | 16 | 0 | 1 | 10 | 0 | 1 | 4 | 0 | 0 | 16 | 0 | 0 | 7 | 0 |

As all articles have an intrinsic value, and the price will be in proportion to it, so it is with hop-poles, that the annual cost to the planter will be about the same whatever sort or length he buys (although, as in most things, the best is the cheapest), taking a term of 20 years together, as the following table will show:—

A Table showing about the Annual Cost of keeping a Ground supplied with Poles, taking the prices of the ash, willow, and maple, the mixed 12 and 10 feet poles, as shown in a foregoing Table:—

| | £. | s. | d. |
|---|---|---|---|
| 18-feet poles, 3000 on an acre, will require, to keep it supplied, 400 new poles, at 40s. . . . . . . . . . . | 8 | 0 | 0 |
| Value of 400 poles taken out, at 12s. . . . . . . | 2 | 8 | 0 |
| Net cost . . . . . . | 5 | 12 | 0 |
| 16-feet poles, 3000 on an acre, will require 500 new poles, at 34s. . | 8 | 10 | 0 |
| 500 poles taken out, at 10s. . . . . . . . | 2 | 10 | 0 |
| | 6 | 0 | 0 |
| 14-feet poles, 3000 on an acre, will require 600 new poles, at 28s. . | 8 | 8 | 0 |
| 600 poles taken out, at 8s. . . . . . . . . | 2 | 8 | 0 |
| | 6 | 0 | 0 |
| 12-feet poles, 3600 on an acre, will require 1000 new poles, at 16s. . | 8 | 0 | 0 |
| 1000 poles taken out, at 4s. . . . . . . . | 2 | 0 | 0 |
| | £6 | 0 | 0 |

To the above annual cost of 6*l.* per acre must be added the carriage of poles home; sharping and shaving those that require it, will be about 7*l.* per acre annual expenditure for poles, leaving the poles in about the same state, and of the same value, as when the hop-ground was taken; or if the planter has furnished a new-planted ground with all new poles, no new ones will be required for the next year, and but few for several years of the large sorts of poles, but the average annual cost will be about the same, calculating the depreciation of the value of them.

I have now gone through a practical statement of the mode of managing hops in all its various branches as required, which has extended to a much greater length than I at first contemplated; but the subjects to be treated on are numerous, and I was not willing that any should escape unnoticed, and however unnecessary much that I have said may appear to the experienced planter, I trust there is nothing but what may be useful to those who wish for information on the subject.

I now take my leave of the reader by giving a statement of the expense of cultivating an acre of hop-ground previous to picking, according to the prices stated in this Essay, under the different heads; but much depends on the various circumstances, such as the local situation of the hop-ground, labour and poles being higher in some districts than others, the great variation of the rent of hop-grounds in different localities, from 1*l.* to 5*l.* per acre, and in some instances more considerably. Mr. Lance states, in his 'Hop Farmer,' that some hop-grounds at Farnham have sold as high as 600*l.* per acre, and that many pieces would find customers at 25*l.* per acre per annum rental; it consequently is impossible to give in one a statement embracing the whole, my calculations shall, therefore, be made on grass-land to be broken up, of the annual value of 2*l.* per acre in that state, which will serve as data wherewith to come to some conclusion as to the expense under different circumstances in any locality.

I shall also subjoin a calculation of picking and every other subsequent expense, until the hops are sold by the factor; but this will be best done by the cwt., which differs but little in different years, or districts, the only difference being the cost of picking in short-crop years and large ones, and the little variations there may be in the price of fuel and packages.

In all the calculations I have ever seen published of the expense of cultivating an acre of hop-ground, and the subsequent expenses of picking, drying, duty, &c., I have never seen a correct one, a great many small items being generally omitted, although not one of them may be much in itself, but on the aggregate they are considerable. I shall, therefore, in the following calculations endeavour to state every item of expense. I have also been surprised that the amount of duty on the hops should generally be published so incorrectly, calculating 2*d.* per lb. on the gross weight, making it 18*s.* 8*d.* per cwt., besides the last additional duty of 5 per cent.; whereas 1 lb. in every 10 lb. is allowed by the Excise without a charge, leaving the duty of 2*d.* per lb. to be charged on the nett of 100·8 lb., which is 16*s.* 9½*d.* $\frac{4}{10}$ per cwt., amounts to 16*l.* 16*s.* per ton, which, with the new duty of 5 per cent., is 17*l.* 12*s.* 9½*d.* $\frac{4}{10}$ per ton, and is within a fraction of 17*s.* 8*d.* per cwt. now paid, with the additional 5 per cent. included on a gross cwt. of hops, as weighed and marked on the packages by the Excise. The

weight they are sold by, is the gross cwt., whatever it may be when weighed to the merchant, after deducting 2 lb. for each draught, the usual allowance to the trade.

First cost of planting an acre of hops on old meadow or pasture, 1200 hills to an acre.

| | £. | s. | d. |
|---|---|---|---|
| Ploughing 2 furrows deep and subsoiling | 3 | 6 | 0 |
| Harrowing and rolling | 0 | 5 | 0 |
| Setting out hills | 0 | 2 | 0 |
| 6000 cut sets at 6*d.* per 100 | 1 | 10 | 0 |
| Planting ditto | 0 | 4 | 6 |
| Manuring with lime 200 bushels, carriage and spreading | 4 | 0 | 0 |
| Twisting up the young bine, repairing and dressing hills in autumn, including bedded sets required to mend with, on an average | 0 | 15 | 0 |
| Expenses of first year | £10 | 2 | 6 |

Supposing the crop of roots grown to pay rent, tithe, taxes, and summer cultivation, over and above the expense of seed, planting, extra manure required for them, &c.

Second year.

| | £. | s. | d. |
|---|---|---|---|
| Expense of first year as above | 10 | 2 | 6 |
| One year's interest on ditto at 5 per cent. | 0 | 10 | 1½ |
| Digging the ground | 1 | 0 | 0 |
| Dressing being done the last autumn, there will be only levelling down the hills | 0 | 3 | 0 |
| 3600 small poles at 4*s.* per 100 | 7 | 4 | 0 |
| Carriage of ditto from other ground, and sharpening 8*d.* per 100 | 1 | 4 | 0 |
| Poling the small poles already sharpened, 10*d.* per 100 hills | 0 | 10 | 0 |
| Tying | 0 | 10 | 0 |
| Digging around hills at 6*d.* per 100 | 0 | 6 | 0 |
| Nidgeting during the summer | 1 | 4 | 0 |
| Occasionally hoeing around hills and weeds in alleys | 0 | 5 | 0 |
| Putting up blown down poles during the summer | 0 | 2 | 0 |
| Rent 2*l.*, ordinary tithe and taxes 16*s.*, half extraordinary tithe 10*s.* | 3 | 6 | 0 |
| | £26 | 6 | 7½ |

N.B. The second year is calculated without manure, supposing the lime laid on in the autumn in the first year to be sufficient for fresh broken-up land, but manure might or not be used as was thought fit, increasing the expense 5*l.* per acre, which would depend on the price of hops whether it paid for doing.

| | £. | s. | d. | £. | s. | d. |
|---|---|---|---|---|---|---|
| Deduct from second year's profit of crop above the expense of picking, drying, duty, &c., which is very uncertain, there might be 10 cwt. per acre, or if blighted none; say 5 cwt., at 4*l.* per cwt. | £20 | 0 | 0 | | | |
| Deduct picking, drying, and duty, 2*l.* per cwt. | 10 | 0 | 0 | | | |
| | 10 | 0 | 0 | | | |
| Value of 3600 old poles above the expense of moving, 1*s.* 6*d.* per 100 | 2 | 14 | 0 | | | |
| | | | | 12 | 14 | 0 |
| Leaving a balance against the acre of hop-ground the second year | | | | 13 | 12 | 7½ |
| To furnish new poles for the next year, supposing them to be poles of mixed wood, half 14 feets at 24*s.*, half 12 feets at 16*s.*, 1800 each | | | | 36 | 0 | 0 |
| Average carriage of each 3*s.* per 100 | | | | 5 | 8 | 0 |
| | | | | £55 | 0 | 7½ |

Balance against an acre of hop-ground the second year, and the expense of furnishing an acre of new poles being shown to be 55*l.*, the amount of which, with interest thereon, should be equally divided over the number of years the ground is continued in plant; but as that is always uncertain, it will be better in an annual calculation to charge the average annual cost to keep up a supply of poles as in a former calculation, which was 7*l.* per acre, charging interest on the cost of poles with the expense above the produce of the two first years, supposing the poles to be kept in the same state with that annual supply, or if not, there is a depreciation in the value of the poles equal to the omission of such supply.

Annual expense of cultivating an acre of hops of 1200 hills.

| | £. | s. | d. |
|---|---|---|---|
| Manuring every year, and occasionally twice a year . . . | 7 | 0 | 0 |
| Digging the ground 1*l.*, cutting or dressing 6*s.* . . . . | 1 | 6 | 0 |
| Poling 15*s.*, carrying in new poles 1*s.* 6*d.* . . . . . . | 0 | 16 | 6 |
| Annual supply of poles . . . . . . . . . . | 7 | 0 | 0 |
| Tying 10*s.*, digging around hills at 6*d.* per 100, 6*s.* . . . . | 0 | 16 | 0 |
| Nidgeting during the summer, as shown under the head of summer cultivation . . . . . . . . . . . . | 1 | 4 | 0 |
| Hoeing at times 5*s.*, ladder-tying 1*s.*, earthing 3*s.* . . . . . | 0 | 9 | 0 |
| Putting up poles blown and broke down during the summer and sundries | 0 | 5 | 0 |
| Stacking poles, binding quarters and bines . . . . . . | 0 | 5 | 0 |
| Rent 2*l.*, ordinary tithe and taxes 16*s.*, extraordinary tithe 1*l.* . . | 3 | 16 | 0 |
| Rent and taxes, and repairs on oast and buildings required for drying, &c., the annual expense of which is the same whether there are many hops grown or few . . . . . . . . . . . | 1 | 0 | 0 |
| Interest on money sunk in raising a plantation, and the first cost of poles, 55*l.* as before stated . . . . . . . . . . | 2 | 14 | 0 |
| The 13*l.* 12*s.* sunk in raising a plantation the first two years, as only interest on it is yet charged, we will extend it, say over 14 years, about | 1 | 0 | 0 |
| As manure and labour is paid for some considerable time before anything is received for produce, I will put that at 20*l.* and charge it at half a year's interest . . . . . . . . . . | 0 | 10 | 0 |
| Total . . . . . . . . . | £28 | 1 | 6 |

On high rented hop-grounds it will of course be more, according to the rent given; also, when larger and better sorts of poles are used, the interest on the capital employed will be more; and where hand-cultivation only is adopted, the annual expense would be more.

The above is the lowest calculation that can be made consistent with good management; if done at a less expense, the planter is not likely to be so well remunerated.

A calculation of picking and every subsequent expense on a ton weight of hops until they are sold, supposing half a ton per acre to be grown, averaging 1300 bushels of green hops to a ton when dried, and 1*s.* given for picking 8 bushels:—

| | £. | s. | d. |
|---|---|---|---|
| Picking 1300 bushels, at 8 bushels for a shilling . . . . | 8 | 2 | 6 |
| It will require 10 bins' companies of 8 pickers each to pick 1300 bushels in a day, consequently 10 binmen 1 day each at 2*s.* 3*d.* . . . | 1 | 2 | 6 |
| Carried over . . | £9 | 5 | 0 |

| | £. | s. | d. |
|---|---|---|---|
| Brought over . . | 9 | 5 | 0 |
| One man to measure at 3*s*., a lad or young man to tally and keep accounts at 3*s*. | 0 | 6 | 0 |
| Boy, van, and one horse from morning to night, to carry the pokes to the ground, carry green hops home, &c. | 0 | 6 | 0 |
| Fuel for drying 1*l*. 5*s*., carriage of ditto 5*s*. | 1 | 10 | 0 |
| Brimstone ¾ of a cwt. to a ton, at 12*s*. per cwt. | 0 | 9 | 0 |
| 65 yards of pocketing for 13 pockets, at 7*d*. per yard | 1 | 17 | 11 |
| Making and marking 13 pockets, and ink, at 2*d*. each | 0 | 2 | 2 |
| Treading and puting in 13 pockets at 10*d*. | 0 | 10 | 10 |
| Two dryers, one at 6*s*. per day, under one 5*s*. per day | 0 | 11 | 0 |
| 5 gallons of beer per day for dryers, treaders, &c., at 1*s*. | 0 | 5 | 0 |
| Annual supply of new pokes and bincloths, wear and tear of old ones | 0 | 6 | 0 |
| Ditto wear and tear of oast hairs and hop bins, and other articles | 0 | 5 | 0 |
| Sundries, such as men to help weigh hops, move and load ditto, and various other jobs | 0 | 6 | 0 |
| Loss of time from wet on labour paid by day, to average 3 days through hop picking, 1 day's work 2*l*. 10*s*. 6*d*., 3 days 7*l*. 11*s*. 6*d*., about | 0 | 10 | 0 |
| Wood for fuel, and straw for foreign pickers, equal to | 0 | 10 | 0 |
| Gift to each picker and binman of 1*s*. each, with beer on finishing | 0 | 8 | 0 |
| Carriage of 13 pockets to London, at 2*s*. each | 1 | 6 | 0 |
| Factorage or factor's commission, 4*s*. each | 2 | 12 | 0 |
| Duty | 17 | 12 | 9½ |
| Total cost per ton . . . . . | £38 | 18 | 8½ |

In blight years, as more per bushel is given for picking, and as there will not be so many hops, it will cost more per ton to pull the poles; that taking it in round numbers, if we were to average the cost of picking and subsequent expenses one year with another at 40*l*. per ton, 40*s*. per cwt., we should not be very wide of the mark.

END OF VOL. IX.

London: Printed by William Clowes and Sons, Stamford Street.

# Royal Agricultural Society of England.

1847—1848.

## Honorary Members.

BUCKLAND, The Very Rev. WILLIAM, D.D., Dean of Westminster.

CARR, Captain J. STANLEY, Duchy of Lauenburg.

COLMAN, HENRY, Agricultural Commissioner of the State of Massachusetts.

DAUBENY, CHARLES, M.D., Professor of Rural Economy, University of Oxford.

DE LA BECHE, Sir HENRY THOMAS, Director of the Ordnance Geological Survey.

EVERETT, The Hon. EDWARD, President of Cambridge University, U. S.

FOWNES, Dr. GEORGE, Professor of Practical Chemistry, University College, London.

GERMANY, His Imperial Highness John, Archduke-Regent of.

GRAHAM, THOMAS, Professor of Chemistry, University College, London.

HENSLOW, The Rev. J. S., Professor of Botany, University of Cambridge.

HOFMANN, Dr., Professor of Chemistry, Royal College of Chemistry, London.

JOHNSTON, JAMES F. W., Reader in Chemistry, University of Durham.

LIEBIG, Baron, University of Giessen.

MURCHISON, Sir RODERICK I., K.S.P., President of the Royal Geographical Society.

PARKES, JOSIAH, C.E., 11, Great College Street, Westminster.

PLAYFAIR, Dr. LYON, Chemist to the Ordnance.

SOLLY, EDWARD, Professor of Chemistry, Hortic. Society, and Addiscombe College.

SPRENGEL, Dr. CHARLES, Secretary to the Pomeranian Agricultural Society.

STEVENSON, The Hon. ANDREW, Washington.

VAN DE WEYER, M. SYLVIAN, Belgian Minister.

WAY, JOHN THOMAS, Consulting-Chemist to the Society.

# Royal Agricultural Society of England.

## GENERAL MEETING,

12, Hanover Square, Saturday, December 11, 1847.

### REPORT OF THE COUNCIL.

The Council have been actively engaged during the last half-year, in carrying out, to the best of their ability, the various objects of the Society; either by a direct extension of their operations, or by such modifications of detail as experience may have led them to adopt: and in every change which they have effected for the promotion of these objects, they have, as in every former period of their proceedings, been most anxiously careful that no false step on their part should endanger the hitherto safe and steady progress of the Society in its career of usefulness, and the development of its powers for the common good of the country. They have the satisfaction of finding, that as the sphere of the Society's operations becomes enlarged, it maintains its progress in a uniform and steady course, but that while every advantage is taken of the light which science may throw on its path, they can securely rely on that beacon only for their guidance which practical experience has established. They trust that the motto of the Society, "Practice with Science," will continue, as it has hitherto done, to regulate its movements; and that science will be regarded simply as that knowledge of principles which is derived from observation or experiment, and its deductions adopted only when the cases are similar in circumstance and condition:—that while theory suggests modes of improve-

ment, practical experience will ever be held as the only safe test whereby to decide the question of their adoption.

The Council are enabled to lay before the Members a most favourable report of the state of the Society in each of its executive departments.

The Finance Committee will present to the Meeting the balance-sheet of the general account as examined, and certified as correct by the Auditors of the Society. They will also submit the special balance-sheet of the Northampton Meeting, exhibiting a considerably diminished amount of charge against the funds of the Society as compared with previous years.

During the last half-year 57 Members have died, 221 have, on various assigned reasons, ceased to be members, and 193 New Members have been elected. The Society accordingly now consists of—

| | |
|---|---|
| 93 | Life Governors, |
| 190 | Annual Governors, |
| 634 | Life Members, |
| 5369 | Annual Members, |
| 20 | Honorary Members ; |

making a total of 6,306 Members.

The Chairman of the Journal Committee has submitted to the Council the new part of the Journal of the Society, which completes the volume for the year ; and its immediate distribution will take place among the Members of the Society, under the usual regulations.

The Country Meeting at Northampton has proved one of the most successful of those hitherto held by the Society—in the number of implements exhibited, the quality of the stock, and the assemblage of visitors in the Show-yard. The Society, before leaving Northampton, passed unanimous votes of thanks to the Mayor and Corporation, and to the Local Committees and other official authorities acting under their instructions, for the manner in which they had so zealously and cordially co-operated with the Council in promoting the success of the Meeting; and the Council conveyed to Mr. Shaw, of Cotton End, their best ac-

knowledgments of the essential services he had so kindly rendered to the Stewards of the Implement-yard in the discharge of thier arduous duties.

The Council, in appointing the Judges of Stock for the Northampton Meeting, especially called their attention to those standing instructions of the Society which require the Judges of Neat Cattle, Sheep, and Pigs, in making their awards, to take into their consideration not the market value to the butcher of the animals exhibited, but their qualities as breeding stock; and the Judges of Horses to take activity and strength into their consideration in addition to symmetry. The Council have also agreed to the following rules for the nomination of Judges:—"That any Member of the Society who nominates a Judge be requested to certify, that of his own personal knowledge he knows him to be qualified and willing to act as a Judge for whatever classes he may be proposed to be appointed, and who is unconnected with any exhibitor of stock or maker of implements, and has no direct personal interest in the stock exhibited as the breeder of any particular animals upon which he might be called upon to adjudicate. That the list of names so proposed (stating by whom proposed) be, as heretofore, referred to the Committee of the Council, whereof the Stewards of the Yard of the year preceding be *ex officio* Members. That in case a sufficient number of competent persons is not proposed, the Committee are ordered to add the names of such other persons as they may know to be competent and willing to act." It has also been arranged that in future one Steward of the Yard in each department will go out of office each year by rotation.

The Society was last year deeply indebted to the principal Railway Companies throughout the kingdom, who most handsomely conveyed, free of charge—both to and from the Show—all stock and implements entered for exhibition at Northampton; and their liberality was found so essentially to contribute to the success of the Meeting, that the Council addressed their thanks to the Directors of each of the Companies who had thus so highly favoured the Society. The Council, however, being sensible of

the serious inconvenience which may possibly arise to the several Companies from the abuse of this privilege, have resolved, on their next application, to solicit, in the case of implements, a free passage only *to* the Show; while for the live stock to be entered for competition they intend to ask as before for a free transit in *both* directions.

In order to check the entry of stock or implements for the Country Meetings of the Society, and their specification in the printed catalogues, as well as the unnecessary expense of a preparation of space for their exhibition in the show-yard, when such stock and implements were either not intended at the time of entry to be sent to the show, or have been withheld upon insufficient grounds, the Council have resolved to inflict certain fines, according to the amount of head of stock, or the value of the implements so entered; admitting, however, all just pleas in lieu of those fines, for all such accidental or unavoidable causes of omission, as the Council shall allow to be valid:—and for affording facilities to the implement-makers to complete the specification of their details for insertion in the catalogue, the Council have resolved to require only the entry of the particular implements to be exhibited, and the space they will require in the show-yard, as heretofore, by the 1st of May, allowing a further month, namely, to the 1st of June, for the completion of such specifications.

The Society have concluded with the authorities of the City of York an official agreement in reference to the Country Meeting of next year; and arrangements for the proceedings on the occasion have already been commenced. The Yorkshire Agricultural Society have liberally placed at the disposal of the Council the sum of 450*l.* for the promotion of the objects of the Meeting; and the Council having already decided on offering a prize of 50*l.* for the best Report of the Agriculture of the West Riding of Yorkshire, appropriated 100*l.* out of this local fund for like Reports on the Agriculture of the other two Ridings. The remaining sum of 350*l.* has been referred for appropriation to the General York Committee of the Society. This liberality on

the part of the Yorkshire Agricultural Society, and that of the Lord Mayor and Corporation of the City, in a subscription of 1,000*l.* towards the purposes of the Meeting, will enable the Council to make arrangements for the Meeting of 1848 on a scale of undiminished extent; and they have already decided on the Prizes to be offered out of the funds of the Society for stock and implements on that occasion.

The Council have unanimously appointed Professor Way, the author of papers in the Journal, on the Analysis of the Ashes of Plants, to be the Consulting Chemist of the Society, in the place of Dr. Lyon Playfair, whose increasing engagements prevent him from devoting to the office that amount of time and attention which he conceives its important duties to require. The Council have had the pleasing duty of conveying to Dr. Lyon Playfair their acknowledgments of the services he has rendered to the Society, and their satisfaction of finding from him, that, as one of their Honorary Members, he will still have it in his power to promote the objects of the Society, as occasions from time to time arise.

At the request of Professor Way, the Council have invited their Members to supply him with certain specimens of Grain, in order that he may obtain analyses of average specimens of particular districts, as well as of the whole country; an invitation to which the Members have most kindly attended.

The Council have to express to Professor Way, and to Professor Simonds, Lecturer on Cattle Pathology in the Royal Veterinary College, their best thanks for the Lectures they kindly consented at a short notice to deliver before the Members on the occasion of their present General Meeting.

In conclusion, the Council congratulate the Members on the great amount of good conferred by the Society, directly as well as indirectly, on the agriculture of the country, both in pointing out improved modes of culture and management, and in proving in many instances a safeguard against the delusion and error arising from untried theories or unsound practice. The first successful evidence of the value of the Society's operations has

been to disseminate whatever has come under its notice as most valuable for adoption, rendering that knowledge of instances of good farming more general, which had so long been confined to particular local districts of the kingdom; and the Council entertain every well-grounded hope, that so long as the Society promotes as it does the united and friendly energies of the owners and occupiers of land in the common cause of the improvement of the country, its operations will continue equally practical and important, and tend to the mutual interest of such parties themselves, as well as to that of the community at large.

By order of the Council,

(Signed) JAMES HUDSON,
*Secretary.*

*London, Dec.* 9, 1847.

## ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending 30th June, 1847.

| Receipts. | £. | s. | d. |
|---|---|---|---|
| Balance in the hands of the Bankers, 1st January, 1847 | 3356 | 0 | 8 |
| Ditto in the hands of the Secretary, 1st January, 1847 | 10 | 19 | 11 |
| Dividends on Stock | 129 | 7 | 4 |
| Life Compositions of Governors | 150 | 0 | 0 |
| Life Compositions of Members | 232 | 0 | 0 |
| Annual Subscriptions of Governors | 713 | 10 | 0 |
| Annual Subscriptions of Members | 2590 | 9 | 9 |
| Sale of Journal | 195 | 10 | 6 |
| Sale of Cottage Tracts | 6 | 17 | 6 |
| Receipts during the half-year on account of the Country Meetings | 42 | 10 | 0 |
| Major Curteis's Prize for Essay on the Hop-fly | 10 | 0 | 0 |
| | £7437 | 5 | 8 |

| Payments. | £. | s. | d. |
|---|---|---|---|
| Purchase of Stock | 1822 | 0 | 0 |
| Permanent Charges | 270 | 12 | 6 |
| Taxes and Rates | 18 | 2 | 2 |
| Establishment Charges | 543 | 12 | 9 |
| Postage and Carriage | 33 | 18 | 2 |
| Advertisements | 9 | 13 | 6 |
| Expenses of Journal | 1464 | 11 | 2 |
| Printing, &c. of Cottage Tracts | 10 | 12 | 0 |
| Prizes | 338 | 15 | 6 |
| Payments during the half-year on account of the Country Meetings | 768 | 16 | 2 |
| Analysis of Ashes of Plants | 209 | 15 | 6 |
| Subscriptions repaid | 15 | 0 | 0 |
| Miscellaneous Items | 6 | 3 | 11 |
| Balance in the hands of the Bankers, 30th June, 1847 | 1895 | 4 | 3 |
| Ditto in the hands of the Secretary, 30th June, 1847 | 30 | 8 | 1 |
| | £7437 | 5 | 8 |

(Signed) THOMAS RAYMOND BARKER,
C. B. CHALLONER,
HENRY BLANSHARD,
} *Members of the Finance Committee.*

Examined and audited this 10th day of December, 1847, and found correct.

(Signed) C. H. TURNER,
THOMAS KNIGHT,
} *Auditors on the part of the Society.*

## SPECIAL COUNTRY MEETING ACCOUNT: NORTHAMPTON, JULY, 1847.

| Receipts. | £. | s. | d. |
|---|---|---|---|
| Subscription from Northampton | 1200 | 0 | 0 |
| Sale of Pavilion Dinner Tickets | 512 | 0 | 6 |
| Show-yard Receipts | 2473 | 11 | 0 |
| Sale of Catalogues | 370 | 10 | 4 |
| Sale of Council Badges | 9 | 0 | 0 |
| Excess of Expenditure over the Receipts on account of the Northampton Meeting, chargeable on the general Funds of the Society | 297 | 13 | 2 |
| | £4862 | 15 | 0 |

| Payments. | £. | s. | d. |
|---|---|---|---|
| Pavilion Dinner | 570 | 0 | 0 |
| Pavilion Contract | 640 | 0 | 0 |
| Show-yard and Trial of Implements | 2522 | 14 | 2 |
| London Police | 153 | 11 | 0 |
| Judges | 274 | 0 | 0 |
| Printing | 360 | 7 | 7 |
| Stationery | 15 | 12 | 0 |
| Advertisements | 272 | 6 | 2 |
| Postage, Carriage, and Travelling Expenses | 25 | 6 | 1 |
| Official Staff Charges | 16 | 15 | 10 |
| Porters in Charge of Rooms | 2 | 0 | 0 |
| Council Badges | 1 | 18 | 2 |
| Agreements | 3 | 11 | 8 |
| Surveyor's Plans | 3 | 3 | 0 |
| Miscellaneous Items | 1 | 9 | 4 |
| | £4862 | 15 | 0 |

(Signed) THOMAS RAYMOND BARKER,
C. B. CHALLONER,
HENRY BLANSHARD.

# Essays and Reports.

## I. AWARDS MADE IN 1847—1848.

To James M'Adam, junior, of Belfast, the prize of Twenty Sovereigns, with the Marquis of Downshire's addition of Thirty Sovereigns, for the best Essay on the Cultivation and Management of Flax.

To George Legard, of Fangfoss, near Pocklington, the prize of Fifty Sovereigns, for the best Report on the Farming of the East Riding of Yorkshire.

To Thomas Rowlandson, of Douglas-street, Bootle-lane, Liverpool, the prize of Twenty Sovereigns, for the best Essay on the Cultivation of Hemp.

To Robert Smith, of Burley, Rutlandshire, the prize of Thirty Sovereigns, for the best Essay on the Management of Grass Land.

To John H. Charnock, of Wakefield, the prize of Fifty Sovereigns, for the best Report on the Farming of the W. Riding of Yorkshire.

To John Bravender, of Cirencester, the prize of Fifty Sovereigns, for the best Report on the Farming of Gloucestershire.

To Henry Tanner, of the Hermitage, Newbury, the prize of Fifty Sovereigns, for the best Report on the Farming of Devonshire.

To Hall William Keary, of Longlands, Holkham, Norfolk, the prize of Thirty Sovereigns, for the best account of the Management of Cattle.

To Thomas L. Colbeck, of East Denton, near Newcastle-upon-Tyne, the prize of Twenty Sovereigns, for the best Report on the Use of Lime as a Manure.

To George Waters, junior (Member of the R. Coll. of Vet. Surg.), of St. Andrew's Hill, Cambridge, the prize of Fifty Sovereigns, for the best Report on the Pleuro-Pneumonia amongst Cattle.

To Samuel Rutley, of West Yaldham, Wrotham, Kent, the prize of Twenty Sovereigns, for the best Account of the Management of Hops.

## II. PRIZES OFFERED FOR 1849.

*All Prizes of the Royal Agricultural Society of England are open to general competition.*

### I. Farming of Lancashire.

Fifty Sovereigns will be given for the best Report on the Farming of Lancashire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities, whether advantageous or defective, in its agricultural management.
3. The improvements effected in the farming of Lancashire since the Report of R. W. Dickson in the year 1814.
4. The improvements still required, whether in higher cultivation, reclamation of waste lands, general or local drainage; or in the condition, including the dwelling, of the farm-labourer.

### II. Farming of Sussex.

Fifty Sovereigns will be given for the best Report on the Farming of Sussex.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities, whether advantageous or defective, in its agricultural management.
3. The improvements effected in the farming of Sussex since the Report of the Rev. Arthur Young in the year 1808.
4. The improvements still required, whether in higher cultivation, diminution of fences, breaking-up of grass-land, extirpation of charlock, or in the improvement of the dwellings and condition of the farm-labourer.

### III. Farming of South Wales.

Fifty Sovereigns will be given for the best Report on the Farming of South Wales.

Competitors will be expected to describe—

1. The character of the soils of the district.

2. The peculiarities, whether advantageous or defective, in its agricultural management.
3. The improvements effected in the farming of South Wales since the Report of Walter Davies in the year 1814.
4. The improvements still required, with reference to the climate and character of South Wales, as to the higher culture of existing farms, the reclamation of waste lands, whether for cultivation or improved pasture, and the condition and dwellings of the farm-labourer.

### IV. Labourers' Cottages.

Fifty Sovereigns will be given for the best Essay on the Construction of Labourers' Cottages; and

Twenty Sovereigns will be given for the second-best Essay on the same subject.

Competitors will be required to state—

The best and most economical mode of building a pair of labourers' cottages, with three bed-rooms in each. The paper to be accompanied by plans, elevations, and specifications, with prices affixed, enabling those who are desirous of building cottages to calculate the cost accurately. If ornament be introduced, the same to be estimated separately. The winner of the first prize will be expected, if requested, to supply a model for the use of the Society.

### V. Increasing Animal Food.

Fifty Sovereigns will be given for an Essay on the best Method of Increasing the existing Supply of Animal Food within the United Kingdom.

Competitors will be required to state—

1. The sources from which the supplies of lean stock are *now* derived, and whether such supplies are on the increase or decrease.
2. How far it is consistent with improved husbandry that farmers in general should breed their own stock.
3. How the supply of animal food is affected by sending stock to the butcher at a very early age.
4. How the supply of breeding and fat stock will be affected by breaking-up pastures.

### VI. Management of Barley.

Fifteen Sovereigns will be given for the best Report on the Management of Barley.

Competitors will be required to attend to the following points :—

1. Preparation of the land.
2. Advantages and risks of early sowing.
3. Different varieties as suited to various situations.

### VII. Breeding and Management of Pigs.

Twenty Sovereigns will be given for the best account of the Breeding and Management of Pigs.

Competitors will be expected to describe—

1. The various breeds of pigs.
2. Their respective merits for conversion into fresh meat, pickled pork, bacon, and ham, with the modes of preparing the same.
3. The best and most economical mode of rearing, keeping, and fattening them.

### VIII. Top-dressing of Soil with Mineral Substances.

Fifteen Sovereigns will be given for the best Essay on the Top-dressing of Soil with Mineral substances.

Competitors will be required to state—

1. The different methods of effecting the same with chalk, marl, clay, &c.
2. The cost of the operation.
3. The advantages derived therefrom.

### IX. Breeds of Sheep for different Localities.

Twenty Sovereigns will be given for the best Report on the Breeds of Sheep best suited to different localities respectively, with reference to soil, climate, elevation, and mode of farming.

### X. Farm-Buildings.

Fifty Sovereigns will be given for the best Essay on the Construction of Farm Buildings.

Competitors will be required to furnish—

Plans, elevations, and a working estimate (as in No. IV.) for farm-buildings (exclusive of dwelling-house) suited for a farm of moderate size, from 200 to 300 acres, at a reasonable cost, and adapted to the requirements of a practical farmer.

## XI. Destruction of Wireworm.

Fifty Sovereigns will be given for the best Essay on the Destruction of the Wireworm.

*** This prize will not be awarded until the 1st of March, 1850, and the award will be founded on success by actual trial.

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*These Essays (with the exception of No. XI.) must be sent to the Secretary, at* 12, *Hanover Square, London, on or before March* 1st, 1849.

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*** Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.

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## RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, and the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of such Essays, not obtaining the Prize, as he may think likely to be useful for the Society's objects, with a view of consulting the writer confidentially as to his willingness to place such paper at the disposal of the Journal Committee.

6. The copyright of all Essays gaining prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

# Royal Agricultural Society of England.

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## GENERAL MEETING,

12, Hanover Square, Monday, May 22, 1848.

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### REPORT OF THE COUNCIL.

The Council report to the members at their present general Meeting that during the past half-year,

139 new members have been elected,
31 have died,
82 have been struck off the list, and that the Society now consists of—

| | |
|---|---|
| 93 | Life-Governors, |
| 186 | Annual Governors, |
| 648 | Life Members, |
| 5387 | Annual Members, |
| 21 | Honorary Members. |
| Total . . | 6335 |

Mr. Hudson, M.P., has been elected to supply the vacancy in their body, occasioned by the decease of Mr. Browne.

The Council have to express their regret that Mr. Parkes, in consequence of his other professional engagements, has found it necessary to resign the office of Consulting Engineer; but they have the pleasure of stating, that, as an Honorary Member of the Society, he has signified his readiness to assist the Council with his skill and experience.

In order to render their meetings more convenient to all parties, the Council have altered that part of the Bye-laws which prescribes Wednesday as the day of meeting; and have decided that, after the expiration of the current month, the monthly and weekly meetings of the Council shall be held on Tuesday, instead

of Wednesday, the usual hour of meeting remaining at 12 o'clock, as heretofore.

They have also decided that, agreeably with the privilege conferred by the recent Treasury order, regulating the transmission of books through the Post-office, the Journal of the Society shall be issued by Post on the day of publication to each member whose subscription is not in arrear.

The Council have, after due investigation, determined to adopt at the approaching Country Meeting a simple and improved method of testing the comparative efficiency of the implements to be selected for trial on that occasion; and they have decided that in addition to the Consulting Engineer of the Society, who will act as the mechanical referee, there shall be ten judges of implements, two of these engineers, and the remaining eight practical farmers. That the two engineers shall be the sole judges of steam-engines and of steam power generally, considered in a scientific and mechanical point of view, without reference to the application of such power to agricultural machinery; but that they shall report to the stewards, in writing, for the information of the other judges, a statement of the power applied to the machinery under the consideration of any such judges. Also, that the other judges shall judge the work done by any agricultural machine to which steam or other power is applied; but that it shall be an instruction to them to pay every attention to the report of the engineers in forming their judgment of the work of the machinery on which they are called upon to adjudicate.

The Council are in communication with the directors of the various railway companies throughout the kingdom, respecting the transit of live stock, and implements to and from the place of exhibition; and they hope, through the liberal co-operation of those railway companies, to make such arrangements as will be satisfactory to all parties.

In compliance with the strong local feeling expressed to the Council, they have decided to hold a Council Dinner at York.

Professor Johnston, of Durham, and Professor Simonds, Lecturer on Cattle Pathology in the Royal Veterinary College, Lon-

don, have each consented to deliver a Lecture before the members of the Society, on consecutive evenings, during the period of the York Meeting: the former, on the application of Science to Agriculture; and the latter, on the Anatomy, Physiology, Functions, and Diseases of Domesticated Animals.

The Council have decided to afford the public admission into the cattle-yard, under certain regulations and conditions, on the Wednesday evening, after all the judges have delivered in their awards.

The number of agricultural implements entered for the York Meeting far exceeds that of any former year; and, from the numerous entries of live stock already sent in for that exhibition, as well as from the favourable circumstances under which the York Meeting will be held, the Council have the fullest assurance that the ensuing Country Meeting in that city will fully realize their most sanguine anticipations.

They have accepted the invitation of the authorities of Norwich to hold the Country Meeting for the Eastern District of England, in 1849, in that city; and, in conformity with the practice of the Council, they have decided that the district for the Country Meeting in 1852 shall be comprised of the whole of South Wales, with the addition of the counties of Monmouth, Gloucester, Hereford, and Worcester; the district for the meetings to be held in the intermediate years having been already determined, namely, the South-Western District for 1850, and the South-Eastern for 1851.

The Council, in conclusion, have the satisfaction of reporting the successful progress of the Society in the gradual development of its power of promoting the extension of knowledge in reference both to the science and practice of agriculture: and supported as the Society so cordially has been, and continues to be, throughout the kingdom, the Council cannot entertain a doubt of the continuance of its prosperity and usefulness.

By order of the Council,

(Signed) JAMES HUDSON,

*Secretary.*

*London, May* 19, 1848.

# ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending 31st December, 1847.

RECEIPTS.

| | £. | s. | d. |
|---|---|---|---|
| Balance in the hands of the Bankers, 1st July, 1847 | 1895 | 4 | 3 |
| Ditto in the hands of the Secretary, 1st July, 1847 | 30 | 8 | 1 |
| Dividends on Stock | 141 | 19 | 4 |
| Life Compositions of Governors | 50 | 0 | 0 |
| Life Compositions of Members | 275 | 10 | 0 |
| Annual Subscriptions of Governors | 180 | 0 | 0 |
| Annual Subscriptions of Members | 2190 | 2 | 0 |
| Sale of Journal | 153 | 16 | 0 |
| Sale of Cottage Tracts | 3 | 13 | 7 |
| Receipts during the half-year on account of the Country Meetings | 143 | 5 | 8 |
| Sale of Council Badges | 9 | 0 | 0 |
| | £5072 | 18 | 11 |

PAYMENTS.

| | £. | s. | d. |
|---|---|---|---|
| Permanent Charges | 278 | 12 | 6 |
| Taxes and Rates | 17 | 1 | 2 |
| Establishment Charges | 447 | 10 | 9 |
| Postage and Carriage | 36 | 16 | 6 |
| Advertisements | 7 | 13 | 0 |
| Expenses of Journal | 652 | 12 | 0 |
| Prizes | 1347 | 15 | 6 |
| Marquis of Downshire's addition to prize for Essay on Flax | 30 | 0 | 0 |
| Payments during the half-year on account of the Country Meetings | 1005 | 8 | 0 |
| Analysis of Ashes of Plants | 100 | 0 | 0 |
| Subscriptions allowed | 2 | 0 | 0 |
| Miscellaneous Payments | 5 | 15 | 0 |
| Balance in the hands of the Bankers, 31st December, 1847 | 1106 | 3 | 1 |
| Ditto in the hands of the Secretary, 31st December, 1847 | 35 | 11 | 5 |
| | £5072 | 18 | 11 |

(Signed) THOMAS RAYMOND BARKER, *Chairman*, C. B. CHALLONER, } *Finance Committee.*

Examined, audited, and found correct, this 19th day of May, 1848.

(Signed) C. H. TURNER, THOMAS KNIGHT, } *Auditors on the part of the Society.*

## General Meetings of 1848—9.

The General December Meeting, in London, on Saturday, December 9, 1848.

The General May Meeting, in London, on Tuesday, May 22, 1849.

The Annual Country Meeting, at Norwich, in 1849.

Election of Members.—Candidates for admission into the Society must be proposed by a Member, the proposer to specify in writing the name, rank, usual place of residence, and post-town, of the candidate, either at a Council, or by letter to the Secretary. Every such proposal shall be read at the Council at which such proposal is made; or, in case of the Candidate being proposed by a letter to the Secretary, at the first meeting of the Council next after such letter shall have been received. At the next Meeting of the Council the election shall take place, when the decision of the Council shall be taken by a show of hands; the majority of the Members present to elect or reject. The Secretary shall inform Members of their election by a letter, in such form as the Council may from time to time direct. All Members belong to the Society, and are bound to pay their annual subscriptions. Members not in arrear of their subscription may withdraw from the Society by a notice in writing to the Secretary. Governors to pay an annual subscription of 5*l.*, and Members of 1*l.*; all subscriptions being due on the 1st of January in each year; but when the election takes place in November or December, the subscription paid in those months will be considered as the subscription of the following year. Governors may compound for their lives by paying 50*l.*; Members, by paying 10*l.*

Subscriptions may be paid to the Secretary, in the most direct and satisfactory manner, either at the office of the Society, No. 12, Hanover Square, London, between the hours of ten and four, or by means of Post-office orders, to be obtained on application at any of the principal Post-offices throughout the kingdom, and made payable to him at the General Post-office, London; but any Cheque on a London Banker, or other House of Business in London, will be equally available, if made payable on demand. The subscriptions are due in advance, for each year, on the 1st of January; and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal, or to any other privileges of the Society, whose subscription is in arrear.

Volumes of the Journal.—The first Volume of the Journal consists of *four* parts, the second and third Volumes of *three* parts each (the second and third parts of the third Volume being comprised in a double number), and the fourth of *two* parts. The Journal is now published half-yearly, namely, the first half-volume for each year about the beginning of July, and the second about the end of December or beginning of January, and is transmitted by post as published to each Member of the Society whose subscription is not in arrear at the date of publication.

Cottage Economy.—Mr. Main's article on Cottage Gardening, and Mr. Burke's compilation on Cottage Economy and Cookery, have each been reprinted from the Journal in a separate form, for cheap distribution. Either or both of these tracts may be obtained by members at the rate of 1*s.* per dozen copies, on their enclosing to the Secretary a Post-office money-order for the number required; at the same time stating the most eligible mode of conveyance by which the copies can be transmitted to their address. They are also sold to the public, at 2*d.* each, by the Society's Publisher, Mr. Murray, 50, Albemarle Street, London.

# Country Meeting at York.

PRINCIPAL DAY OF THE SHOW, JULY 13, 1848.

## LIST OF JUDGES.

| | | |
|---|---|---|
| SHORT HORNS. | BENJAMIN SWAFFIELD | Chatsworth, Derbyshire. |
| | CHARLES STOKES | Kingston, Nottinghamshire. |
| | WILLIAM TORR | Aylesby, Lincolnshire. |
| | JAMES WALKER | Newberries, Hertfordshire. |
| HEREFORDS, DEVONS, AND OTHER BREEDS. | HENRY CHAMBERLAIN | Desford, Leicestershire. |
| | J. C. ETCHES | Harely Thorn, Staffordshire. |
| | WILLIAM JAMES | Hereford, Herefordshire. |
| HORSES. | WILLIAM GREAVES | Matlock-Bath, Derbyshire. |
| | W. C. SPOONER | Southampton, Hampshire. |
| | WILLIAM DAY | Ensham, Oxfordshire. |
| | W. F. KARKEEK | Truro, Cornwall. |
| LEICESTER SHEEP. | THOMAS CHAPMAN | Stoneleigh, Warwickshire. |
| | JOHN WRIGHT | Chesterfield, Derbyshire. |
| | E. L. FRANKLIN | Ascott, Oxfordshire. |
| SOUTH-DOWN SHEEP. | PETER PURVES | Kimbolton, Huntingdonshire. |
| | L. P. MATON | Maddington, Wiltshire. |
| | STEPHEN GRANTHAM | Ryderswells House, Sussex. |
| LONG-WOOLLED SHEEP. | ROBERT BEMAN | Donnington, Gloucestershire. |
| | JOHN CLARKE | Long Sutton, Lincolnshire. |
| | HENRY COX | Scotsgrove, Buckinghamshire. |
| PIGS. | JESSE KEMP | Thurlby Grange, Lincolnshire. |
| | WILLIAM ELLISON | Sizergh Castle, Westmoreland. |
| | JOHN ELLIOT | Chapel Brampton, Northamptonshire. |
| | JOHN CLAYDEN | Littlebury, Essex. |

| | | |
|---|---|---|
| IMPLEMENTS. | RICHARD CLYBURN | Uley, Gloucestershire. |
| | W. N. PARSSON | Gravel Lane, London. |
| | T. P. OUTHWAITE | Bainesse, Yorkshire. |
| | WILLIAM HESSELTINE | Worlaby, Lincolnshire. |
| | PETER LOVE | Naseby, Northamptonshire. |
| | CHARLES PAGET | Ruddington Grange, Nottinghamshire. |
| | OWEN WALLIS | Overstone Grange, Northamptonshire. |
| | JOHN ALMACK, Jun | Leckonfield Park, Yorkshire. |
| | THOMAS BAYLDON | Hollingshurst, Yorkshire. |
| | WILLIAM LISTER | Dunsa Banks, Yorkshire. |

CONSULTING ENGINEER—C. E. AMOS (of the Firm of EASTON and AMOS), The Grove, Southwark, Surrey.

## AWARD OF PRIZES.

### Cattle: I. *Short-Horns.*

Richard Keevil, of Shaw Farm, near Melksham, Wilts: the Prize of Forty Sovereigns, for his 3 years and 2 months-old pure Short-horned Bull; bred by William Garne, of Broadmoore, near Northleach.

Alexander Bannerman, of South Cottage, Chorley: the Prize of Twenty Sovereigns, for his 2 years and 8 months old Short-horned Bull; bred by himself.

William Linton, of Sheriff Hutton, near York: the Prize of Twenty Sovereigns, for his 1 year and 11 months-old Short-horned Bull; bred by himself.

Thomas Chrisp, of Hawkhill, near Alnwick: the Prize of Ten Sovereigns, for his 1 year and 5 months-old Short-horned Bull; bred by himself.

John Mason Hopper, of Newham Grange, near Stockton-on-Tees: the Prize of Twenty Sovereigns, for his 5 years and 4 months-old Short-horned in-milk and in-calf Cow; bred by the late Reverend William Glaister, of Kirby Fleetham, near Catterick, Yorkshire.

Richard Booth, of Warlaby, near Northallerton: the Prize of Ten Sovereigns, for his 3 years 3 months 2 weeks and 1 day-old Short-horned in-milk Cow; bred by himself.

Richard Booth, of Warlaby, near Northallerton: the Prize of Twenty Sovereigns, for his 2 years 4 months and 8 days-old Short-horned in-calf Heifer; bred by himself.

James Banks Stanhope, of Revesby-Abbey, near Boston: the Prize of Ten Sovereigns, for his 2 years and 4 months-old pure Short-horned in-calf Heifer; bred by himself.

William Smith, of West Rasen, Lincolnshire: the Prize of Ten Sovereigns, for his 1 year 6 months and 6 days-old Short-horned yearling Heifer; bred by himself.

John Kirkham, of Hagnaby, near Spilsby: the Prize of Five Sovereigns, for his 1 year and 4 months-old Short-horned yearling Heifer; bred by himself.

### Cattle: II. *Herefords.*

John Nelson Carpenter, of Eardisland, near Leominster: the Prize of Forty Sovereigns, for his 2 years 11 months and 2 days-old Hereford Bull; bred by himself.

Henry Higgins, of Brinsop Court, near Hereford: the Prize of Twenty Sovereigns, for his 4 years and 2 months-old Hereford Bull; bred by James Corbett, of The Sheriffs, near Leominster.

John Monkhouse, of The Stow, near Hereford: the Prize of Twenty Sovereigns, for his 1 year and 8 months old Hereford Bull; bred by himself.

Edward Williams, of Lowess Court, near Hay: the Prize of Ten Sovereigns, for his 1 year and 8 months-old Hereford Bull; bred by William Vaughan, of Cholstrey, near Leominster.

Edward Williams, of Lowess Court, near Hay: the Prize of Twenty Sovereigns, for his 3 years and 9 months-old Hereford in-calf Cow; bred by John Nelson Carpenter, of Eardisland, near Leominster.

Samuel Aston, of Lynch Court, near Leominster: the Prize of Ten Sovereigns, for his 10 years and 7 months-old Hereford in-milk and in-calf Cow; bred by the Reverend J. R. Smythies, of Grey Friars, Colchester.

John Walker, of Holmer, near Hereford: the Prize of Twenty Sovereigns, for his 2 years and 4 months-old Hereford in-calf Heifer; bred by John Nelson Carpenter, of Eardisland, near Leominster.

Samuel Aston, of Lynch Court, near Leominster: the Prize of Ten Sovereigns, for his 2 years and 9 months-old Hereford in-calf Heifer; bred by himself.

William Fisher Hobbs, of Boxted Lodge, near Colchester: the Prize of Ten Sovereigns, for his 1 year 4 months 2 weeks and 5 days-old pure Hereford yearling Heifer; bred by himself.

Samuel Aston, of Lynch Court, near Leominster: the Prize of Five Sovereigns, for his 1 year and 6 months-old Hereford yearling Heifer; bred by himself.

## Cattle: III. *Devons.*

James Hole, of Knowle House, near Dunster, Somerset: the Prize of Forty Sovereigns, for his 4 years and 8 months-old pure Devon Bull; bred by himself.

Thomas White Fouracre, of Durston, near Taunton: the Prize of Twenty Sovereigns, for his 4 years and 10 months-old Devon Bull; bred by himself.

George Turner, of Barton, near Exeter: the Prize of Twenty Sovereigns, for his 2 years and 3 months-old Devon Bull; bred by James Quartly, of Molland, near Southmolton.

The Hon. CAPTAIN DUDLEY PELHAM, R.N., of St. Lawrence, Ventnor, Isle of Wight: the Prize of TEN SOVEREIGNS, for his 2 years and 5 months-old Devon Bull; bred by Richard Merson, of Brindsworthy, near North Molton.

THOMAS BOND, of Bishop's Lydeard, near Taunton: the Prize of TWENTY SOVEREIGNS, for his 4 years and 9 months-old Devon in-calf and in-milk Cow; bred by himself.

THOMAS WHITE FOURACRE, of Durston, near Taunton: the Prize of TEN SOVEREIGNS, for his 5 years and 7 months-old Devon in-milk and in-calf Cow; bred by himself.

THOMAS WHITE FOURACRE, of Durston, near Taunton: the Prize of TWENTY SOVEREIGNS, for his 2 years and 7 months-old Devon in-calf Heifer; bred by himself.

GEORGE TURNER, of Barton, near Exeter: the Prize of TEN SOVEREIGNS, for his 2 years and 3 months-old North Devon in-calf Heifer; bred by himself.

JAMES HOLE, of Knowle House, near Dunster, Somerset: the Prize of TEN SOVEREIGNS, for his 1 year, 4 months, and 2 weeks-old Pure Devon Yearling Heifer; bred by himself.

THOMAS WHITE FOURACRE, of Durston, near Taunton: the Prize of FIVE SOVEREIGNS, for his 1 year and 7 months-old Devon Yearling Heifer; bred by himself.

CATTLE: IV. *Any Breed* (not qualified to compete as Short-horns, Herefords, or Devons).

EDWARD CANE, of Berwick Court, near Lewes: the Prize of TWENTY-FIVE SOVEREIGNS, for his 3 years and 6 months-old Sussex Bull; bred by John Villiers Shelley, of Maresfield Park, Sussex.

JOHN BOWES, of Streatlam Castle, near Barnard Castle: the Prize of FIFTEEN SOVEREIGNS, for his 11 years and 4 months old Argyle in-milk Cow; bred by himself.

THOMAS BEARDS, of Stowe, near Buckingham: the Prize of TEN SOVEREIGNS, for his 2 years, 8 months, and 5 days-old pure Long-horned in-calf Heifer; bred by the Duke of Buckingham, of Stowe, near Buckingham.

THOMAS BEARDS, of Stowe, near Buckingham: the Prize of TEN SOVEREIGNS, for his 1 year and 9 months-old pure Long-horned Yearling Heifer; bred by himself.

## Horses.

Marquis of Downshire, of Hillsborough Castle, County of Down, Ireland: the Prize of Thirty Sovereigns, for his 5 years-old Stallion, of the Suffolk-Punch Breed; bred by Sir Francis Lawley, Bart., of Middleton Hall, near Fazeley, Staffordshire.

John Ward, of East Mersid, Colchester: the Prize of Fifteen Sovereigns, for his 7 years-old Stallion of the Suffolk Breed; bred by Samuel Wrinch, of Great Holland, Essex.

George Townshend, of Sapcote Fields, near Hinckley: the Prize of Twenty Sovereigns, for his 3 years-old Cart Stallion; bred by himself.

Henry Eddison, of Gateford, near Worksop: the Prize of Fifteen Sovereigns, for his 2 years-old Stallion of the Carting Breed; bred by himself.

John Dennison, of Morker, near Ripon: the Prize of Ten Sovereigns, for his 2 years-old Cart Stallion; bred by The Reverend Joseph Charnock, of Fountains Hall, near Ripon.

Anthony Chibnall, of Bromham, near Bedford: the Prize of Twenty Sovereigns, for his Cart Mare and Foal: the sire of the Foal belonged to himself, but the breeder of the mare is unknown.

Lord Saint John, of Melchbourne, near Higham Ferrers: the Prize of Ten Sovereigns, for his 10 years-old Mare (with her Foal) for agricultural purposes: the sire of the Foal was bred by himself, but the breeder of the mare is unknown.

Lord Saint John, of Melchbourne, near Higham Ferrers: the Prize of Ten Sovereigns, for his 2 years-old Filly for agricultural purposes; bred by himself.

Lord Saint John, of Melchbourne, near Higham Ferrers: the Prize of Five Sovereigns, for his 2 years-old Filly for agricultural purposes; bred by himself.

## Sheep: I. *Leicesters.*

John Borton, of Barton-le-Street, near Malton: the Prize of Thirty Sovereigns, for his 14 months-old pure Leicester Ram; bred by himself.

Robert Blyth Harvey, of Pulham St. Mary, near Harleston, Norfolk: the Prize of Fifteen Sovereigns, for his 16½ months-old Leicester Ram; bred by himself.

John Borton, of Barton-le-Street, near Malton: the Prize of Thirty Sovereigns, for his 27 months-old pure Leicester Ram; bred by himself.

William Fisher Hobbs, of Boxted Lodge, near Colchester: the Prize of Fifteen Sovereigns, for his 28 months-old new Leicester Ram; bred by himself.

William Sanday, of Holme Pierrepoint, near Nottingham: the Prize of Twenty Sovereigns, for his pen of five 16 months-old Leicester Shearling Ewes; bred by himself.

William Sanday, of Holme Pierrepoint, near Nottingham: the Prize of Ten Sovereigns, for his pen of five 16 months-old Leicester Shearling Ewes; bred by himself.

### Sheep: II. *Southdowns.*

Jonas Webb, of Babraham, near Cambridge: the Prize of Thirty Sovereigns, for his 16 months-old Southdown Ram; bred by himself.

John Villiers Shelley, of Maresfield Park, near Uckfield: the Prize of Fifteen Sovereigns, for his 16 months-old Southdown Ram; bred by himself.

William Sainsbury, of West Lavington, near Devizes: the Prize of Thirty Sovereigns, for his 29 months-old Southdown Ram; bred by himself.

George Drake, of the Manor Farm, East Tytherley, near Stockbridge: the Prize of Fifteen Sovereigns, for his 28 months-old Pure Southdown Ram; bred by himself.

His Grace the Duke of Richmond, of Goodwood, near Chichester: the Prize of Twenty Sovereigns, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

John Villiers Shelley, of Maresfield Park, near Uckfield: the Prize of Ten Sovereigns, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

### Sheep: III. *Long-Wools.*

George Hewer, of Ley Gore, near Northleach: the Prize of Thirty Sovereigns, for his 16 months-old Cotswold Ram; bred by himself.

George Hewer, of Ley Gore, near Northleach: the Prize of Fifteen Sovereigns, for his 16 months-old Cotswold Ram; bred by himself.

William Garne, of Aldsworth, near Northleach: the Prize of Thirty Sovereigns, for his 40 months-old Cotswold Ram; bred by himself.

Edward Handy, of Sevenhampton, near Andoversford: the Prize of Fifteen Sovereigns, for his 52 months-old Improved Cotswold Ram; bred by himself.

Charles Large, of Broadwell, near Lechlade: the Prize of Twenty Sovereigns, for his pen of five 16 months-old New Oxfordshire Long-woolled Shearling Ewes; bred by himself.

William Simpson, of Kirby Grindalyth, near Sledmere: the Prize of Ten Sovereigns, for his pen of five 15 months-old Long-woolled Shearling Ewes; bred by himself.

## Pigs.

Richard Hobson, M.D., of Park House, Leeds: the Prize of Fifteen Sovereigns, for his 2 years and 3 months-old Boar of a large breed; bred by himself.

Richard Hobson, M.D., of Park House, Leeds: the Prize of Five Sovereigns, for his 1 year and 4 months-old Boar of a large breed; bred by John Hopper, of Darlington.

Robert Smith, of Givendale, near Ripon: the Prize of Fifteen Sovereigns, for his 11 months 2 weeks and 4 days-old Boar of a small black breed; bred by himself, from a Boar purchased of William Fisher Hobbs.

William Fisher Hobbs, of Boxted Lodge, near Colchester: the Prize of Five Sovereigns, for his 45 weeks and 1 day-old Improved Essex Boar of a small breed; bred by himself.

Joseph Tuley, of Exley Head, near Keighley: the Prize of Ten Sovereigns, for his 3 years-old Sow of a large breed; bred by Samuel Clarkson, of Leeds.

Edwin Eddison, of Headingley Hill, near Leeds: the Prize of Ten Sovereigns, for his 2 years 6 months and 13 days-old Sow of a small breed; bred by Mellish Chambers, of Hodsock, Nottinghamshire.

Joseph Tuley, of Exley Head, near Keighley: the Prize of Ten Sovereigns, for his pen of three 8 months and 2 weeks-old Breeding Sow Pigs of a large breed; bred by himself.

John Roper, of Keighley: the Prize of Ten Sovereigns, for his pen of Three 9 months and 3 weeks-old Breeding Sow Pigs of a small breed; bred by himself.

## IMPLEMENTS.

William Busby, of Newton-le-Willows, near Bedale, for the Plough best adapted to heavy land . . . Ten Sovereigns.

John Howard and Son, of Bedford, for the Plough best adapted to light land . . . . . . Ten Sovereigns.

RICHARD HORNSBY, of Spittlegate, Grantham, for the best Drill for general purposes . . . . FIFTEEN SOVEREIGNS.

RICHARD GARRETT, of Leiston Works, near Saxmundham, for the best Turnip Drill on the flat . . . . TEN SOVEREIGNS.

RICHARD HORNSBY, of Spittlegate, Grantham, for the best Turnip Drill on the ridge . . . . . . TEN SOVEREIGNS.

JOHN WOOD SHARMAN, of Wellingborough; WILLIAM PROCTOR STANLEY, of Peterborough; and THOMAS JOHNSON, of Leicester: for the best Scarifier or Grubber . . . . TEN SOVEREIGNS.

JOHN WHITEHEAD, of Preston, for the best Machine for making Draining Tiles or Pipes for Agricultural Purposes TWENTY SOVEREIGNS.

JOHN HOWARD and SON, of Bedford, for the best Harrow FIVE SOVEREIGNS.

JOHN WOOD SHARMAN, of Wellingborough; WILLIAM PROCTOR STANLEY, of Peterborough; and THOMAS JOHNSON, of Leicester, for the best and most economical Steaming Aparatus for general purposes TEN SOVEREIGNS.

GEORGE KILBY, of Queniborough, near Leicester, for the best Skim or Paring Plough . . . . . FIVE SOVEREIGNS.

JAMES WILMOT NEWBERRY, of Hook Norton, near Chipping Norton, for the best Horse Seed-dibbler . . TEN SOVEREIGNS.

JOHN EATON, of Woodford, near Thrapstone, for the best One-Horse Cart . . . . . . . FIVE SOVEREIGNS.

RICHARD STRATTON, of Bristol, for the best Waggon TEN SOVEREIGNS.

RICHARD GARRETT, of Leiston Works, near Saxmundham, for the best Thrashing Machine applicable to Horse or Steam Power TWENTY SOVEREIGNS.

RICHARD HORNSBY, of Spittlegate, Grantham, for the best portable or fixed Steam Engine applicable to Thrashing or other Agricultural purposes . . . . . . FIFTY SOVEREIGNS.

RICHARD HORNSBY, of Spittlegate, Grantham, for the best Corn-Dressing Machine . . . . . . TEN SOVEREIGNS.

BARRETT, EXALL, and ANDREWES, of Katesgrove Iron Works, Reading, for the best Gorse Bruiser . . . FIVE SOVEREIGNS.

RICHARD HORNSBY, of Spittlegate, Grantham, for the best Implement for distributing Pulverized Manures broadcast TEN SOVEREIGNS.

WILLIAM NEWZAM NICHOLSON, of Newark-on-Trent, for the best and cheapest Grate or Stove for Cottages, combining safety and economy of Fuel, with effectual Warmth and facility for Cooking FIVE SOVEREIGNS.

WILLIAM CROSSKILL, of the Beverley Iron Works, Beverley, for his Improved Norwegian Harrow . . . SILVER MEDAL.

SMITH and Co., of Stamford, for their Patent Double-action Hay-maker SILVER MEDAL.

WILLIAM HENSMAN and SON, of Woburn, Beds, for their Horse Drag Rake . . . . . . . SILVER MEDAL.

RICHARD GARRETT, of Leiston Works, near Saxmundham, for his Patent Horse Hoe on the flat, No. 9. . . . SILVER MEDAL.

WILLIAM BUSBY, of Newton-le-Willows, near Bedale, for his Horse Hoe on the ridge . . . . . SILVER MEDAL.

WILLIAM BUSBY, of Newton-le-Willows, near Bedale, for his Grass Land Cultivator . . . . . SILVER MEDAL.

JOHN WOOD SHARMAN, of Wellingborough; WILLIAM PROCTOR STANLEY, of Peterborough; and THOMAS JOHNSON, of Leicester, for their Linseed and Corn Crushing Machine . SILVER MEDAL.

THOMAS CHANDLER, of Stockton, near Heytesbury, for his Liquid Manure Drill . . . . . SILVER MEDAL.

JOHN CORNES, of Barbridge, near Nantwich, for his Registered Chaff Cutting Machine, with three knives . . SILVER MEDAL.

WILLIAM NEWZAM NICHOLSON, of Newark-on-Trent, for his strong Machine for breaking Oil Cake for Beasts, &c. SILVER MEDAL.

WILLIAM CROSSKILL, of the Beverley Iron Works, Beverley, for his Archimedean Root Washer . . . SILVER MEDAL.

DEANE, DRAY, and DEANE, of No. 3, Arthur Street East, near London Bridge, for their Cesspool and Tank Cleanser SILVER MEDAL.

ROBERT BRUCKSHAW, of Longslow, near Market Drayton, for his Compound Lever Cheese Press . . . SILVER MEDAL.

JOHN SUMMERS, of Wold Newton, near Bridlington, for his Implement for removing Shocks of Corn, &c. . . SILVER MEDAL.

ROBERT BLUNDELL, of No. 13, Theberton Street, Islington, near London, for his Agricultural Drainage Level SILVER MEDAL.

GEORGE HOWE, of 119, Great Guildford Street, Southwark, for his Improvements in the Transparent Water-Gauge as attached to his Steam-Engine . . . . . SILVER MEDAL.

RICHARD ROBINSON, of Belfast, for his Steaming Apparatus SILVER MEDAL.

RICHARD ROBINSON, of Belfast, for his Apparatus and Machinery for Steeping, Breaking, and Scutching Flax . SILVER MEDAL.

WILLIAM HENSMAN AND SON, of Woburn, Beds, for their Self-acting Hopper as applied to their Drill. . . SILVER MEDAL.

THOMAS ABBEY, of Dunnington, near York, for his Thrashing, Shaking, and Dressing Machine . . . . SILVER MEDAL.

CHARLES BURRELL, of Thetford, for his Portable Thrashing, Straw-shaking, and Dressing Machine . . . SILVER MEDAL.

## LOCAL PRIZES:

*Competed for, under the General Regulations of the Society, by parties occupying a House or Land within the County of York.*

CATTLE: *Short Horns.*

HENRY AMBLER, of Watkinson Hall, near Halifax: the Local Prize of TWENTY SOVEREIGNS, for his 3 years and 3 months-old Short-horned Bull; bred by the Earl of Carlisle, of Castle Howard, Yorkshire.

THOMAS BATES, of Kirkleavington, near Yarm: the Local Prize of TEN SOVEREIGNS, for his 4 years 11 months and 13 days-old Short-horned Bull; bred by himself.

WILLIAM LINTON, of Sheriff Hutton, near York: the Local Prize of TWENTY SOVEREIGNS, for his 1 year and 11 months-old Short-horned Bull; bred by himself.

JOHN B. THOMPSON, of Anlaby, near Hull: the Local Prize of TEN SOVEREIGNS, for his 1 year and nearly 5 months-old Short-horned Bull; bred by R. F. Shawe, of Brantingham, near South Cave, Yorkshire.

RICHARD BOOTH, of Warlaby, near Northallerton: the Local Prize of TEN SOVEREIGNS, for his 5 years 2 months and 5 days-old Short-horned in-milk Cow; bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton: the Local Prize of TEN SOVEREIGNS, for his 2 years 4 months and 8 days-old, and 2 years 7 months and 15 days-old, pair of Short-horned in-calf Heifers; bred by himself.

HORSES.

RICHARD GAUNT, of Hall Field Cottage, near Wetherby: the Local Prize of THIRTY SOVEREIGNS, for his 8 years-old thorough-bred Stallion, qualified to get Hunters; bred by the late Christopher Wilson, of Oxton, near Tadcaster.

SILVESTER REED, of York: the Local Prize of FIFTEEN SOVEREIGNS, for his 6 years-old Racing or Blood Stallion, qualified to get Hunters; bred by Lord Wenlock, of Escrick Park, near York.

JONATHAN SHAW, of Acomb Hall, near York: the Local Prize of THIRTY SOVEREIGNS, for his 4 years-old Stallion, qualified to get Carriage-Horses; bred by John Swainby, of Addlesford.

HENRY ELGIE, of Thrintoft, near Northallerton: the Local Prize of FIFTEEN SOVEREIGNS, for his 3 years-old Stallion, qualified to get Carriage-Horses; bred by himself.

JOHN WAKE, of Market Weighton: the Local Prize of TWENTY SOVEREIGNS, for his 4 years-old Stallion, qualified to get Roadsters; bred by himself.

JOHN LANGDALE, of Leckonfield Park, near Beverley: the Local Prize of TWENTY SOVEREIGNS, for his 3 years-old Cleveland Stallion; bred by Mr. Robert Lakes, of Scorbrough, near Beverley.

WILLIAM FIRTH, of Kirkstall, near Leeds: the Local Prize of TWENTY SOVEREIGNS, for his Mare and Foal for Hunting Purposes; bred by Joseph Musgrave, of Bramley, near Leeds; the sire of the Foal belonged to Richard Gaunt, of Wetherby.

JAMES MEWBURN, of Leake House, near Thirsk: the Local Prize of TEN SOVEREIGNS, for his Mare and Foal for Hunting Purposes; the breeder of the Mare unknown; the sire of the Foal belonged to George Holmes, of Thirsk.

ROBERT GOODLASS, of Hutton Cranswick, near Driffield: the Local Prize of TWENTY SOVEREIGNS, for his Mare and Foal for Carriage Purposes; the Mare bred by William Goodlass, of Hutton Cranswick; the sire of the Foal belonged to David Holliday.

JAMES HAW, of Flawith, near Easingwold: the Local Prize of TEN SOVEREIGNS, for his Mare and Foal for Carriage Purposes; breeder of the Mare unknown; the sire of the Foal belonged to H. Stafford Thompson, of Fairfield, near York.

HENRY RICKATSON, of Upsall, near Thirsk: the Local Prize of TWENTY SOVEREIGNS, for his Cleveland Mare and Foal; the breeder of the Mare unknown; the sire of the Foal belonged to George Holmes, of Thirsk.

### SHEEP: I. *Leicesters.*

JOHN BORTON, of Barton-le-Street, near Malton: the Local Prize of FIFTEEN SOVEREIGNS, for his 14 months-old Pure Leicester Ram; bred by himself.

W. E. BOTTERILL, of East Thorpe, near Market Weighton: the Local Prize of FIVE SOVEREIGNS, for his Pen of five 15 months-old Leicester Shearling Ewes; bred by himself.

### SHEEP: II. *Long-Wools.*

WILLIAM SIMPSON, of Kirby Grindalyth, near Sledmere: the Local Prize of FIFTEEN SOVEREIGNS, for his 15 months-old Long-woolled Ram; bred by himself.

WILLIAM SIMPSON, of Kirby Grindalyth, near Sledmere: the Local Prize of FIVE SOVEREIGNS, for his Pen of five 15 months-old Long-wooled Shearling Ewes; bred by himself.

### PIGS.

RICHARD HOBSON, M.D., of Park House, Leeds: the Local Prize of FIVE SOVEREIGNS, for his 2 years and 3 months-old Boar, of a large breed; bred by himself.

ROBERT SMITH, of Givendale, near Ripon: the Local Prize of FIVE SOVEREIGNS, for his 11 months 2 weeks and 4 days-old Black Boar, of the small breed; bred by himself, from a Boar purchased of W. Fisher Hobbs.

TIMOTHY SMITH, of Hoyland Hall, near Barnsley: the Local Prize of FIVE SOVEREIGNS, for his 1 year and 9 months-old Sow, of a large breed; bred by John Winder, of Bramsworth.

MARK STAINSBY, junior, of Lady Pit Lane, Hunslet, near Leeds: the Local Prize of FIVE SOVEREIGNS, for his 2 years and 10 months-old Sow, of a small breed; bred by Richard Hobson, M.D., of Park House, Leeds.

[This award to Mr. Stainsby having been disputed by Mr. Eddison (in favour of his own animal, which gained the Society's Prize in competition with Mr. Stainsby's), the Council have decided to take the question into consideration at their Monthly Meeting on the 7th of November, 1848.—J. H.]

## Commendations.

Anthony Lax Maynard, of Marton-le-Moor, near Ripon: for his 3 years and 4 months-old Short-Horned Bull; bred by himself.

James Stewart, of Clapham, near Settle: for his 3 years and 5 months-old pure Short-Horned Bull; bred by himself.

Viscount Hill, of Hawkstone, near Shrewsbury: for his 3 years and 3 months-old Short-Horned Bull; bred by himself.

*Henry Ambler, of Watkinson Hall, near Halifax: for his 3 years and 3 months-old Short-Horned Bull; bred by the Earl of Carlisle, of Castle Howard, Yorkshire.

John Hall, of Kiveton Park, near Sheffield: for his 4 years and 2 months-old Short-Horned Bull; bred by himself.

*Thomas Bates, of Kirkleavington, near Yarm: for his 4 years 11 months and 13 days-old Short-Horned Bull; bred by himself.

*William Tod, of Elphinstone Tower, near Tranent, N.B.: for his 3 years and 1 month-old Short-Horned Bull; bred by John Black, of Dalkeith, N.B.

Earl of Harewood, of Harewood, near Leeds: for his 4 years and 7 months-old Durham Short-Horned Bull; bred by John Emmerson, of Eyreholme, near Darlington.

Lord Feversham, of Helmsley, Yorkshire: for his 1 year and 5 months-old Short-Horned Bull; bred by himself.

William David Fergusson, of Rosebank, near Rathfarnham, Ireland: for his 2 years and 11 days-old Short-Horned Bull; bred by himself.

Joshua Knowles, of Tinsley, near Sheffield: for his 2 years and 4½ months-old Short-Horned Bull; bred by himself.

*John B. Thompson, of Anlaby, near Hull: for his 1 year and nearly 5 months-old Short-Horned Bull; bred by R. F. Shawe, of Brantingham, near South Cave, Yorkshire.

*Thomas Wetherell, of Kirkbridge, near Darlington: for his 1 year and 5 months-old Short-Horned Bull; bred by himself.

*William Smith, of West Rasen, near Market Rasen: for his 1 year 11 months and 3 days-old Short-Horned Yearling Heifer; bred by himself.

Edward Price, of the Courthouse, Pembridge: for his 3 years and 4 months-old Hereford Bull; bred by David Williams, of Newton, near Brecon.

William Perry, of Cholstrey, near Leominster: for his 2 years 5 months and 23 days-old Hereford Bull; bred by himself.

John Walker, of Holmer, near Hereford: for his 2 years and 3 months-old Hereford Bull; bred by himself.

*Edward Williams, of Lowess Court, near Hay: for his 2 years and 5 months-old Hereford in-Calf Heifer; bred by himself.

Earl of Leicester, of Holkham Hall, Norfolk: for his 2 years and 11 months-old North Devon Bull; bred by George Turner, of Barton, near Exeter.

*George Turner, of Barton, near Exeter: for his 1 year and 6 months-old Devon Bull; bred by himself.

The Hon. Captain Dudley Pelham, R.N., of Saint Lawrence, near Ventnor, Isle of Wight: for his 5 years and 2 months-old North Devon in-Calf and in-Milk Cow; bred by James Davy, of Flitton, near South Molton.

Earl of Leicester, of Holkham Hall, Norfolk: for his 9 years and 3 months-old North Devon in-Milk Cow; bred by himself.

Thomas Bond, of Bishop's Lydeard, near Taunton: for his 2 years and 4 months-old Devon in-Calf Heifer; bred by himself.

James Hole, of Knowle House, near Dunster, Somerset: for his 2 years and 4 months-old pure Devon in-Calf Heifer; bred by himself.

George Turner, of Barton, near Exeter: for his 1 year and 5 months-old North Devon Yearling Heifer; bred by himself.

Henry Bentley, of Oulton, near Leeds: for his 1 year-old Alderney Bull; bred by himself.

Thomas Beale Browne, of Salperton, near Andoversford: for his 3 years-old Suffolk Agricultural Stallion; bred by John Sworder.

Edward and Matthew Reed, of Beamish Burn, near Chester-le-Street: for their 8 years-old Herefordshire Agricultural Stallion; bred by John Stephens, of Sheep-house, near Hay.

*Francis King, of Northallerton: for his 11 years-old Agricultural Stallion; bred by John Redheade, of Levin Grove.

*James Atkinson, of Bramham, near Tadcaster: for his 12 years-old Clydesdale Dray-Stallion; bred by John Frame, of Overton, Lanarkshire, N. B.

William Marshall, of Overton Grange, near York: for his 2 years and 14 days-old Agricultural Stallion; bred by Richard Cortis, of Shipton, near York.

John Setterington, of Hunmanby Moor, near Scarborough: for his 2 years-old Agricultural Stallion; bred by William Smith, of Hunmanby Moor, near Scarborough.

*John Bell, of Stillingfleet, near York: for his 2 years-old Cart Stallion; bred by himself.

*James Douglas, of Athelstaneford, near Haddington, N. B.: for his Agricultural Mare and Foal; the Mare bred by John Gordon, of Clydesdale; the Sire of the Foal belonged to John Shearer, of Lanarkshire.

Richard Foxton, of Welburn, near Kirby Moorside, Yorkshire: for his Agricultural Mare and Foal; the Mare bred by himself; the Sire of the Foal belonged to John Fentriss, of Marton, near Kirby Moorside.

*Henry Green Skipworth, of Rothwell House, Caistor: for his 2 years-old Agricultural Filly; bred by Robert Epworth, late of Grimblethorpe, near Louth.

Edward Handy, of Sevenhampton, near Andoversford: for his 16 months-old improved Cotswold Long-woolled Ram; bred by himself.

*Charles Large, of Broadwell, near Lechlade: for his 16 months-old New Oxfordshire Long-woolled Ram; bred by himself.

*Charles Large, of Broadwell, near Lechlade: for his 28 months-old New Oxfordshire Long-woolled Ram; bred by himself.

*Edwin Eddison, of Headingley Hill, near Leeds: for his 3 years and 28 days-old Boar, of a large breed; bred by David Cooper, of Shadwell, near Leeds.

Barzillai Martin, of Queen Street, Salford, Manchester: for his 2 years and 7 months-old Boar, of a large breed; bred by himself.

Philip Pusey, M.P., of Pusey, near Faringdon: for his 1 year and nearly 1 month-old Berkshire Boar, of a large breed; bred by himself.

Samuel Newton, of Long Millgate, Manchester: for his 4 months and 2 weeks-old Boar of a large breed; bred from his stock.

Joseph Rinder, of Leeds: for his 2 years 5 months and 3 weeks-old improved Sow, of a large breed; bred by himself.

*Edwin Eddison, of Headingley Hill, near Leeds: for his 11 months and 18 days-old Sow, of a large breed; bred by Frank Bailey, of Yorkshire.

*Earl Fitzwilliam, of Wentworth, near Rotherham: for his 2 years and 1 month-old Sow, of a large breed; bred by himself.

*Timothy Smith, of Hoyland Hall, near Barnsley: for his 1 year and 9 months-old Sow, of a large breed; bred by John Winder, of Bramwith.

*John Williamson, of Sheriff Hutton Bridge, near York: for his 1 year and 8 months-old Sow, of a large breed; bred by himself.

Reverend Mitford Bullock, of Skirpenbeck, near Stamford Bridge, Yorkshire: for his 2 years and 6 months-old Sow, of a small breed; bred by himself.

*Earl of Carlisle, of Castle Howard: for his 11 months and 27 days-old pure Short-Horned Bull-Calf; bred by Mark Foulis, of Heslerton, Yorkshire.

*Lord Feversham, of Helmsley: for his 4 years and 10 months-old pure Short-Horned Cow; bred by himself.

John Bowes, of Streatlam Castle, near Barnard Castle: for his 6 years and 3 months-old Argyle Cow; bred by himself.

*THOMAS BATES, of Kirkleavington, near Yarm; for his 8 years 11 months and 5 days-old Short-Horned Cow; bred by himself.

*THOMAS BATES, of Kirkleavington, near Yarm: for his 15 years and 10 months-old Short-Horned Cow; bred by himself.

THOMAS BATES, of Kirkleavington, near Yarm: for his 8 months-old Short-Horned Heifer-Calf; bred by himself.

THOMAS BATES, of Kirkleavington, near Yarm: for his 8 months-old Short-Horned Heifer-Calf; bred by himself.

*DR. TIMM, of Scrooby House, near Bawtry: for his 8 years-old Agricultural and Dray Mare; bred by Lord Saint John, of Melchbourne, near Higham Ferrers.

GEORGE WOOD, of Overton, near York: for his 5 years-old Agricultural Mare; bred by himself.

MOSES CARTWRIGHT, of Stanton Hill, near Burton-on-Trent: for his 2 years and 1 month-old Tamworth Sow; bred by himself.

GEORGE SWANN, of Ashfield, near York: for his pen of three 15 months-old Breeding Sow Pigs, of the small breed; bred by himself.

CHARLES JACKSON, of Fossgate, near York: for his 11 months-old "Gilt" Pig; bred by William Collier, of York.

JOHN ROBINSON, of Leckby Palace, near Topcliffe, Yorkshire: for his pen of three from 4 to 7 months-old Breeding Pigs; bred by himself.

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*General Commendations.*—The Judges "HIGHLY COMMENDED" the Leicester Sheep in Class 2, generally; and "COMMENDED" the Pigs in Classes 2 and 4, generally.

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## LOCAL PRIZES—COMMENDATIONS.

*JOHN MASON HOPPER, of Newham Grange, near Stockton-on-Tees: for his 5 years and 4 months-old Short-Horned in-Milk Cow; bred by Reverend William Glaister, of Kirby Fleetham.

*RICHARD BOOTH, of Warlaby, near Northallerton: for his 4 years 2 months and 15 days-old Short-Horned in-Milk Cow; bred by himself.

*GEORGE HOLMES, of Thirsk: for his 4 years-old Thoroughbred Stallion, qualified to get Hunters; bred by John Backhouse, of York.

WILLIAM WALKINGTON, of Thornton-le-Clay, near York: for his 10 years-old Pure Blood Stallion, qualified to get Hunters; bred by John Lilly, of Manchester.

*WILLIAM BURTON, of Water Fulford, near York: for his 6 years-old Coaching Stallion, qualified to get Carriage-Horses; bred by John Dunn, of Howden.

WILLIAM HODGSON, of Cottingham, near Hull: for his 4 years-old Coaching Stallion, qualified to get Carriage-Horses; bred by himself.

PHILIP RAMSDALE, of Goodmanham, near Market Weighton: for his aged Roadster Stallion; bred by John Bond, of Cawston, Norfolk.

*J. and H. SMITH, of Shipton, near Market Weighton: for their aged Roadster Stallion; bred by themselves.

*THOMAS RICHARDSON, of York: for his 4 years-old Cleveland Stallion; bred by Thomas Crofton, of Holywell, near Durham.

WILLIAM HANSILL, of Castleton, near Guisborough: for his 4 years-old Cleveland Stallion; bred by Richard Rigg, of Egton Bank, near Whitby.

*THOMAS COWPER HINCKS, of Breckenborough, near Thirsk: for his Mare and Foal for Hunting purposes; the Mare bred by John Appleby, of Low Street, near Bedale; the Sire of the Foal belonged to John Bell, of Thirsk.

JOSEPH WILKINSON, of Hunslet, near Leeds: for his Mare and Foal for Hunting purposes; the Sire of the Foal belonged to Richard Gaunt, of Wetherby.

*HENRY ELGIE, of Throntiff, near Northallerton: for his Mare and Foal for Carriage purposes; the Mare bred by himself; the Sire of the Foal belonged to Thomas Rigg, of Danby Wiske.

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[The foregoing Commendations are arranged in the order of the numbers of the Certificates to which they refer. The mark (*) signifies "HIGHLY COMMENDED;" the omission of it, "COMMENDED;" by the Judges.]

# Royal Agricultural Society of England.

1848—1849.

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THE EARL OF CHICHESTER.

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# Norwich Meeting, 1849.

## SCHEDULE OF IMPLEMENT PRIZES,

*Agreed to by the Council on the 1st of August*, 1848.

| | |
|---|---|
| Heavy-land plough | Five Sovereigns. |
| Light-land plough | Five Sovereigns. |
| Plough for general purposes | Five Sovereigns. |
| Paring plough | Five Sovereigns. |
| Subsoil pulveriser | Five Sovereigns. |
| Drill for general purposes | Fifteen Sovereigns. |
| Corn drill | Ten Sovereigns. |
| Turnip drill (on the flat) | Ten Sovereigns. |
| Turnip drill (on the ridge) | Ten Sovereigns. |
| Drop drill (seed and manure) | Ten Sovereigns. |
| Manure distributor † | Five Sovereigns. |
| Portable steam-engine | Fifty Sovereigns. |
| Second best do. | Twenty-five Sovereigns. |
| Portable threshing-machine | Twenty-five Sovereigns. |
| Corn-dressing machine | Ten Sovereigns. |
| Meal-grinding mill | Ten Sovereigns. |
| Linseed and corn crusher | Five Sovereigns. |
| Chaff-cutter | Ten Sovereigns. |
| Turnip-cutter | Five Sovereigns. |
| Cake-breaker | Five Sovereigns. |
| One-horse cart | Ten Sovereigns. |
| Harvest cart | Ten Sovereigns. |
| Waggon | Ten Sovereigns. |
| Drain-tile machine | Twenty Sovereigns. |
| Draining tools | Three Sovereigns. |
| Heavy harrow | Five Sovereigns. |
| Light harrow | Five Sovereigns. |
| Norwegian harrow | Five Sovereigns. |
| Scarifier | Ten Sovereigns. |
| Cultivator, or grubber | Ten Sovereigns. |
| Horse hoe (on the flat) | Ten Sovereigns. |
| Horse hoe (on the ridge) | Five Sovereigns. |
| Horse rake | Five Sovereigns. |
| Horse seed-dibbler | Ten Sovereigns. |
| Hand dibbler | Three Sovereigns. |
| Barrow hand-drill (to work with cups) | Three Sovereigns. |
| Liquid-manure distributor | Five Sovereigns. |
| Haymaking machine | Five Sovereigns. |
| Gorse-bruiser | Five Sovereigns. |
| Steaming apparatus | Five Sovereigns. |
| Silver Medals for miscellaneous awards and essential improvements, estimated at | Twenty-six Sovereigns. |

† To be capable of distributing the manure broad-cast at the rate of from 2 to 20 bush. per acre.

*** The Prizes for Live Stock for the Norwich Meeting will be decided by the Council on Thursday the 7th of December, 1848.

# Royal Agricultural Society of England.

1848—1849.

## President.

THE EARL OF CHICHESTER.

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Braybrooke, Lord
Clive, Hon. Robert Henry, M.P.
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Stansfield, W. R. Crompton, M.P.
Stokes, Charles
Thompson, Henry Stephen
Turner, George
Umbers, Thomas
Webb, Jonas
Wilson, Henry

## Secretary.

JAMES HUDSON, 12, *Hanover Square, London.*

---

*Consulting-Chemist*—JOHN THOMAS WAY, 23, Holles Street, Cavendish Square.
*Consulting-Engineer*—JAMES EASTON, or C. E. AMOS, The Grove, Southwark.
*Seedsmen*—THOMAS GIBBS and Co., Corner of Halfmoon Street, Piccadilly.
*Publisher*—JOHN MURRAY, 50, Albemarle Street.
*Bankers*—H., A. M., C., A. R., G., and H. DRUMMOND, Charing Cross.

# Royal Agricultural Society of England.

## GENERAL MEETING,

12, Hanover Square, Saturday, December 9, 1848.

### REPORT OF THE COUNCIL.

The Council have to report to the Members, on the occasion of their present December Meeting, that during the past half-year 44 of their Members have died, and 105 have ceased to belong to the Society, while 131 new Members have been elected; so that the Society now consists of 91 Life-Governors, 181 Annual Governors, 661 Life-Members, 5232 Annual Members, and 21 Honorary Members, making a total of 6186 Members on the list of the Society at the present time.

The vacancy in the Council, occasioned by the lamented decease of Mr. Harvey, has been filled up by the election of Mr. John Hodgetts Foley, of Prestwood, M.P.

In order to meet the convenience of Members of Parliament, the day for the periodical meetings of the Council has been changed from Wednesday to Tuesday.

The Council regret to inform the Society, that in consequence of the great amount of unpaid subscriptions, they have been under the necessity of borrowing money of their bankers to meet the liabilities consequent upon the York Meeting; and, in order to prevent the recurrence of a similar inconvenience, they have empowered the Finance Committee to take immediate steps for obtaining the arrears, and for securing a more regular payment of subscriptions in future. With the same view, the Council have resolved, that henceforward no Journal shall be sent to any Member whose subscription for the year is unpaid at the time of

publication; and that a list of those Members from whom any subscription shall be due on the Saturday next following the monthly meeting of the Council in August, shall be suspended in the council-room, the names to be classed according to the counties in which the Members reside, with the amount due from each placed opposite to his name. In the meantime the Finance Committee are engaged in making an accurate investigation into the income and expenditure of the Society, with a view of reporting the result to the Council. The Council would further suggest to the Members generally, that it would greatly improve the financial position of the Society, and facilitate their proceedings, if all subscriptions were paid to the bankers on the 1st of January in each year, either by a general order to the bankers of the Member, or by cheque or post-office order addressed to the Secretary. The Council offer to the Members these suggestions with the greater confidence because they find, by their recent circular, that in a great majority of cases of arrear there is every willingness to meet the views and wishes of the Council on the subject.

The Council have the satisfaction of finding that the Treasury Regulation to which they alluded in their last Report, for the transmission of books through the post-office directly to the parties addressed, is likely to prove an invaluable aid in the immediate and certain distribution of the Journal among the Members, however remotely situated, and free of charge. The first issue of the Journal in August last, under these new regulations, has most satisfactorily proved their advantage.

The Country Meeting held at the city of York in July last has realised the most sanguine anticipations of the Council, in the amount and quality of the exhibition, in the success of the practical trials in the show-yard and in the field, and in the ample means of mutual interchange of opinion and detail of personal experience afforded by the assemblage of so large a number of visitors to that Meeting from every part of the country. In addition to these favourable circumstances, the Meeting was honoured by the presence of his Royal Highness Prince Albert, who both

attended the Meeting as a Governor of the Society and graciously identified himself with its objects by evincing a lively interest in the whole of the proceedings. The Council, on leaving York, conveyed to the Lord Mayor and the authorities of the city, and to the local committee, and others who had zealously co-operated with the Council in promoting the success of the Meeting, an expression of their best acknowledgments for their kind exertions on the occasion. Although the receipts of the show-yard were very great, and 1000*l.* was liberally presented to the Society through the authorities of the city, the outlay required for so extensive an assemblage of implements and cattle, and for the elaborate and highly satisfactory trial of implements on the occasion, has proved so great, that over and above the 1383*l.* awarded in prizes for implements and stock, the excess of expenditure over receipts on account of the York Meeting amounts to 1126*l.*, as will be seen by the following tabular statement, in which a comparison is instituted between the result of this and former Meetings:—

| Year of Meeting. | Locality. | Entries of Stock. | Entries of Implements. | Receipts. | Expenditure. | Excess of Expenditure. |
|---|---|---|---|---|---|---|
| | | | | £. | £. | £. |
| 1839 | Oxford . . . | 249 | 23 | 2,394 | 2,688 | 294 |
| 1840 | Cambridge . | 352 | 36 | 3,416 | 3,589 | 173 |
| 1841 | Liverpool . . | 319 | 312 | 4,106 | 5,052 | 946 |
| 1842 | Bristol . . . | 510 | 455 | 4,202 | 4,775 | 573 |
| 1843 | Derby . . . | 730 | 508 | 3,390 | 5,090 | 1,700 |
| 1844 | Southampton . | 575 | 948 | 4,929 | 5,736 | 807 |
| 1845 | Shrewsbury . | 437 | 942 | 3,662 | 5,166 | 1,504 |
| 1846 | Newcastle . . | 613 | 735 | 4,119 | 4,866 | 747 |
| 1847 | Northampton. | 459 | 1,321 | 4,565 | 4,863 | 298 |
| 1848 | York . . . . | 724 | 1,508 | 4,831 | 5,957 | 1,126 |

The Council have the gratification of reporting that the successful issue of the implement trials—a result so long desired, but only imperfectly obtained at former Meetings, was mainly owing to the untiring energy with which the Stewards of that department, the Judges, and the Consulting Engineer acted in concert for the attainment of that great object, by bringing to the test of practical trial those recommendations of the Implement Com-

mittee, of which Colonel Challoner, as its Chairman, had reported on a former occasion to the Council. In order to give Mr. Thompson an opportunity of collecting the materials for his Report upon the exhibition and trial of implements at York, for publication in the Society's Journal, Mr. Shaw, of Northampton, kindly undertook to act as an additional Steward of that department, and rendered to the Society services no less efficient than he had so willingly given at Northampton last year, in promoting the convenience of the Stewards of Implements on that occasion; and the Council have conveyed to him their best thanks accordingly. The Hon. Captain Dudley Pelham, R.N., has kindly undertaken, at the request of the Council, the duties of a Steward of the Implement department, in the place of Mr. Shelley, who, after a long period of efficient service, retires this year by rotation. The Society are much indebted to Professor Johnston, of the University of Durham, and to Professor Simonds, of the Royal Veterinary College, for their kindness in delivering two valuable lectures before the Society during the York Meeting. On occasion of the present December Meeting, Professor Simonds has again favoured the Society, by delivering before the Members in the rooms of the Society two other highly valuable and interesting lectures.

The Council have already made their preliminary arrangements for the Country Meeting to be held next year at Norwich. From the facility of access to that city by sea, the rapidly extending railway accommodation throughout the eastern districts of England; from the character of the stock, and the high reputation of the agriculture in Norfolk and the adjacent counties—they have every reason to anticipate a Meeting in no way second in importance to those that have preceded it. The Council have already voted prizes for the essays, implements, and stock of next year, to the amount of nearly 2000*l.*: of the two former of which the lists were published in the last Journal; while the prize-sheet for the live stock, which was on Thursday last determined in accordance with the bye-laws, has since been printed, and now lies on the table for the information of Members.

The Judges having expressed a desire for an extension of

time for their trial of the implements, without entailing on the exhibitors any additional loss of time or expense, it has been found necessary to devote the whole of the Tuesday in the week of the show to that important purpose. The first day of the public admission to the implement-yard will, consequently, be on Wednesday, the principal day of the show being, as heretofore, on the Thursday. The public working of the implements in the field will therefore be omitted, it having been found by experience quite impossible to conduct that exhibition in a manner satisfactory either to the public or the implement makers.

The Council have renewed for another year the grant for carrying on the analyses of the ashes of plants, a research which they fully believe will eventually lay the foundation for a secure progress in our knowledge of the conditions of vegetable growth, and the most economical and effective means of promoting it in our crops.

In conclusion, the Council have every reason to view with satisfaction the steady advancement of the Society in its sphere of usefulness, and its combining by its central influence the efforts of Societies of a kindred character throughout the kingdom, for agricultural improvement and the public good.

By order of the Council,

(Signed) JAMES HUDSON,
*Secretary.*

*London, Dec.* 1848.

## General Meetings of 1848—9.

The General May Meeting, in London, on Tuesday, May 22, 1849.

The Annual Country Meeting, at Norwich, in 1849.

The General December Meeting, in London, in December, 1849.

# ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending the 30th of June, 1848.

## Receipts.

| | £. | s. | d. |
|---|---|---|---|
| Balance in the hands of the Bankers, January 1st, 1848 | 1106 | 3 | 1 |
| Balance in the hands of the Secretary, January 1st, 1848 | 35 | 11 | 5 |
| Dividends on Stock | 156 | 0 | 2 |
| Life Composition of Governor | 50 | 0 | 0 |
| Life Compositions of Members | 180 | 0 | 0 |
| Annual Subscriptions of Governors | 640 | 5 | 0 |
| Annual Subscriptions of Members | 2061 | 7 | 0 |
| Sale of Journal | 165 | 16 | 9 |
| Sale of Cottage Tracts | 2 | 5 | 8 |
| Fines for non-exhibition at the Country Meeting | 11 | 15 | 0 |
| The Marquis of Downshire's addition to Flax-Prize | 30 | 0 | 0 |
| The Yorkshire Agricultural Society's advance on account of Prize Reports | 100 | 0 | 0 |
| Subscription from York towards the expenses of the Country Meeting of 1848 | 1000 | 0 | 0 |
| Amount of Sums paid in error, or by parties unknown, to the Society's account with their Bankers | 10 | 7 | 0 |
| | £5549 | 11 | 1 |

## Payments.

| | £. | s. | d. |
|---|---|---|---|
| Purchase of Stock | 742 | 0 | 0 |
| Permanent Charges | 270 | 12 | 6 |
| Taxes and Rates | 18 | 2 | 2 |
| Establishment | 528 | 4 | 4 |
| Postage and Carriage | 20 | 6 | 5 |
| Advertisements | 4 | 12 | 0 |
| Expenses of Journal | 1462 | 2 | 9 |
| Prizes | 210 | 0 | 0 |
| Payments during the half-year on account of the Country Meetings | 692 | 8 | 11 |
| Analysis of Ashes of Plants | 280 | 0 | 0 |
| Repayment of Sums transmitted by Bankers and others in error | 9 | 5 | 0 |
| Amount of Miscellaneous Items of Petty Cash | 4 | 13 | 0 |
| Balance in the hands of the Bankers on the 30th of June, 1848 | 1294 | 13 | 9 |
| Balance in the hands of the Secretary on the 30th June, 1848 | 12 | 10 | 3 |
| | £5549 | 11 | 1 |

(Signed) THOMAS RAYMOND BARKER, *Chairman*,
THOMAS AUSTEN,
C. B. CHALLONER,
HENRY BLANSHARD,
} *Finance Committee.*

Examined, audited, and found correct, this 8th day of December, 1848.
(Signed) C. H. TURNER,
THOMAS KNIGHT,
} *Auditors on the part of the Society.*

## SPECIAL COUNTRY MEETING ACCOUNT: YORK, 1848.

*Note.*—The sum of £1700 as the amount of PRIZES awarded by the Society in the year 1848, is not included in this Special Account as an expense attending the York Meeting, but is made chargeable in the General Account as a payment out of the common Funds of the Society.

| RECEIPTS. | £. | s. | d. |
|---|---|---|---|
| Subscription from York | 1000 | 0 | 0 |
| Council Dinner Tickets | 279 | 6 | 0 |
| Pavilion Dinner Tickets | 513 | 10 | 0 |
| Show-yard Receipts | 2664 | 14 | 0 |
| Sale of Catalogues | 365 | 14 | 6 |
| Sale of Council Badges | 7 | 15 | 0 |
| Excess of Payments over Receipts on account of the York Meeting, chargeable on the general Funds of the Society | 1126 | 8 | 7 |
| | £5957 | 8 | 1 |

| PAYMENTS. | £. | s. | d. |
|---|---|---|---|
| Council Dinner | 277 | 10 | 0 |
| Pavilion Dinner | 540 | 0 | 0 |
| Pavilion Contract for Works | 671 | 5 | 0 |
| Show-yard and Trial of Implements | 3080 | 5 | 1 |
| London Police | 231 | 10 | 0 |
| Judges | 337 | 0 | 0 |
| Consulting Engineer | 46 | 15 | 0 |
| Printing, Paper, and Stitching of Catalogues | 295 | 13 | 5 |
| Printing for the special purposes of the Show-yard | 73 | 16 | 6 |
| Printing for the general purposes of the Meeting* | 119 | 15 | 0 |
| Stationery | 20 | 12 | 5 |
| Advertisements | 173 | 4 | 5 |
| Postage, Carriage, and Travelling Expenses | 35 | 16 | 6 |
| Official Staff Charges | 37 | 17 | 3 |
| Porters in Charge of Rooms | 3 | 3 | 0 |
| Council Badges | 5 | 1 | 6 |
| Fire-Brigade | 5 | 0 | 0 |
| Extra Clerks | 2 | 2 | 0 |
| Horses for Police | 1 | 1 | 0 |
| | £5957 | 8 | 1 |

(Signed) THOMAS RAYMOND BARKER,
C. B. CHALLONER.

* This general head includes the following particular items of work executed for the amount charged, namely:—1350 Stock Prize Sheets, 1100 Implement Prize Sheets, 2600 Stock Certificates, 850 Implement Certificates, 1000 Local Certificates, 6100 Programmes, 650 Lists of Stewards, 280 Summonses, 100 Slip Advertisements, 100 Dinner Tenders, 80 Letters to Editors, 160 Letters to Judges, 300 Circulars to Governors, 2200 Railway Certificates for Exhibitors, 1200 Pavilion Dinner Tickets, 327 Council Dinner Tickets, 1000 Lecture Tickets, 250 Wednesday Evening Show-yard Tickets, 250 Preliminary Prize Sheets, 1200 Lists of Toasts, 4000 Award Lists of Stock, 3000 Award Lists of Implements, 100 Letters for Fines, and 150 Placards.

# Essays and Reports.

## I. AWARDS.

To William C. Spooner, Veterinary-Surgeon, Southampton, the prize of Twenty Sovereigns for the best Essay on the Management of Farm-Horses.

To Matthew Marmaduke Milburn, of Sowerby, near Thirsk, Yorkshire, the prize of Fifty Sovereigns, for the best Report on the Farming of the North Riding of Yorkshire.

## II. PRIZES OFFERED.

| | |
|---|---|
| Report on the Farming of Lancashire . . . . | Fifty Sovereigns. |
| Report on the Farming of Sussex . . . . . | Fifty Sovereigns. |
| Report on the Farming of South Wales . . . | Fifty Sovereigns. |
| Essay (and Model, if required) on the Construction of Labourers' Cottages . . . . . . . . | Fifty Sovereigns. |
| Second-best Essay on the Construction of Labourers' Cottages. . . . . . . . . | Twenty Sovereigns. |
| Method of Increasing the Existing Supply of Animal Food . . . . . . . . . . | Fifty Sovereigns. |
| Report on the Management of Barley . . . . | Fifteen Sovereigns. |
| Account of the Breeding and Management of Pigs | Twenty Sovereigns. |
| Essay on the Top-dressing of Soil with Mineral Substances . . . . . . . . . . | Fifteen Sovereigns. |
| Breeds of Sheep for different Localities . . . | Twenty Sovereigns. |
| Construction of Farm-buildings . . . . . | Fifty Sovereigns. |
| Essay on the Destruction of the Wire-worm . . | Fifty Sovereigns. |

*** All Essays competing for these Prizes are to be sent to the Secretary, 12, Hanover-Square, London, on or before the 1st of March, 1849, with the exception of the Essay on the Destruction of the Wire-worm, which may be sent in on or before the 1st of March, 1850. The conditions of competition were given at length in the Appendix to the last part of the Journal (pages xii.-xv.).

# Norwich Meeting, 1849.

## SCHEDULE OF IMPLEMENT PRIZES,

*Agreed to by the Council on the* 1st *of August*, 1848.

NOTE.—The Prize-Sheets, containing the full enunciation of the terms of these Prizes, and the conditions under which the competition for them will take place, will be published in February, 1819, and may be had on application to the Secretary of the Society, 12, Hanover Square, London.

| | |
|---|---|
| Heavy-land plough | Five Sovereigns. |
| Light-land plough | Five Sovereigns. |
| Plough for general purposes | Five Sovereigns. |
| Paring plough | Five Sovereigns. |
| Subsoil pulveriser | Five Sovereigns. |
| Drill for general purposes | Fifteen Sovereigns. |
| Corn drill | Ten Sovereigns. |
| Turnip drill (on the flat) | Ten Sovereigns. |
| Turnip drill (on the ridge) | Ten Sovereigns. |
| Drop drill (seed and manure) | Ten Sovereigns. |
| Manure distributor* | Five Sovereigns. |
| Portable steam-engine | Fifty Sovereigns. |
| Second best do. | Twenty-five Sovereigns. |
| Portable threshing-machine | Twenty-five Sovereigns. |
| Corn-dressing machine | Ten Sovereigns. |
| Meal-grinding mill | Ten Sovereigns. |
| Linseed and corn crusher | Five Sovereigns. |
| Chaff-cutter | Ten Sovereigns. |
| Turnip-cutter | Five Sovereigns. |
| Cake-breaker | Five Sovereigns. |
| One-horse cart | Ten Sovereigns. |
| Harvest cart | Ten Sovereigns. |
| Waggon | Ten Sovereigns. |
| Drain-tile machine | Twenty Sovereigns. |
| Draining tools | Three Sovereigns. |
| Heavy harrow | Five Sovereigns. |
| Light harrow | Five Sovereigns. |
| Norwegian harrow | Five Sovereigns. |
| Scarifier | Ten Sovereigns. |
| Cultivator, or grubber | Ten Sovereigns. |
| Horse hoe (on the flat) | Ten Sovereigns. |
| Horse hoe (on the ridge) | Five Sovereigns. |
| Horse rake | Five Sovereigns. |
| Horse seed-dibbler | Ten Sovereigns. |
| Hand dibbler | Three Sovereigns. |
| Barrow hand-drill (to work with cups) | Three Sovereigns. |
| Liquid-manure distributor | Five Sovereigns. |
| Haymaking machine | Five Sovereigns. |
| Gorse-bruiser | Five Sovereigns. |
| Steaming apparatus | Five Sovereigns. |
| Silver Medals for miscellaneous awards and essential improvements, estimated at | Twenty-six Sovereigns. |

* To be capable of distributing the manure broad-cast at the rate of from 2 to 20 bush. per acre.

# Norwich Meeting, 1849.

## SCHEDULE OF LIVE-STOCK PRIZES,

*Agreed to by the Council on the 7th of December*, 1848.

NOTE.—The Prize-Sheets, containing the full enunciation of the terms of these Prizes, and the conditions under which the competition for them will take place, will be published in February, 1849, and may be had on application to the Secretary of the Society, 12, Hanover Square, London.

### SHORT-HORNED CATTLE.

| | |
|---|---|
| Bull, calved previously to Jan. 1, 1847 | Forty Sovereigns. |
| Second-best ditto ditto | Twenty Sovereigns. |
| Bull, calved since Jan. 1, 1847, more than 1 year old | Twenty Sovereigns. |
| Second-best ditto ditto | Ten Sovereigns. |
| Cow in Milk, or in Calf* | Twenty Sovereigns. |
| Second-best ditto ditto* | Ten Sovereigns. |
| In-calf Heifer, not exceeding 3 years old | Twenty Sovereigns. |
| Second-best ditto ditto | Ten Sovereigns. |
| Yearling Heifer | Ten Sovereigns. |
| Second-best ditto | Five Sovereigns. |

### HEREFORD CATTLE.

| | |
|---|---|
| Bull, calved previously to Jan. 1, 1847 | Forty Sovereigns. |
| Second-best ditto ditto | Twenty Sovereigns. |
| Bull, calved since Jan. 1, 1847, more than 1 year old | Twenty Sovereigns. |
| Second-best ditto ditto | Ten Sovereigns. |
| Cow in Milk, or in Calf* | Twenty Sovereigns. |
| Second-best ditto ditto* | Ten Sovereigns. |
| In-calf Heifer, not exceeding 3 years old | Twenty Sovereigns. |
| Second-best ditto ditto | Ten Sovereigns. |
| Yearling Heifer | Ten Sovereigns. |
| Second-best ditto | Five Sovereigns. |

### DEVON CATTLE.

| | |
|---|---|
| Bull, calved previously to Jan. 1, 1847 | Forty Sovereigns. |
| Second-best ditto ditto | Twenty Sovereigns. |
| Bull, calved since Jan. 1, 1847, more than 1 year old | Twenty Sovereigns. |
| Second best ditto ditto | Ten Sovereigns. |
| Cow in Milk, or in Calf* | Twenty Sovereigns. |
| Second-best ditto ditto* | Ten Sovereigns. |
| In-calf Heifer, not exceeding 3 years old | Twenty Sovereigns. |
| Second-best ditto ditto | Ten Sovereigns. |
| Yearling Heifer | Ten Sovereigns. |
| Second-best ditto | Five Sovereigns. |

### CATTLE OF ANY BREED (*not qualified to compete as Short-horns, Herefords, or Devons: Cross-bred animals being excluded*).

| | |
|---|---|
| Bull, calved previously to Jan. 1, 1847 | Twenty Sovereigns. |
| Second-best ditto ditto | Ten Sovereigns. |
| Bull, calved since Jan. 1, 1847, more than 1 year old | Ten Sovereigns. |
| Cow in Milk, or in Calf * | Ten Sovereigns. |
| Second-best ditto ditto * | Five Sovereigns. |

* If the cow be in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.

| | |
|---|---|
| In-calf Heifer, not exceeding three years old . . | Ten Sovereigns. |
| Yearling Heifer . . . . . . . . . . | Five Sovereigns. |
| Cow for dairy purposes . . . . . . . . | Ten Sovereigns. |
| Second-best ditto . . . . . . . . . . | Five Sovereigns. |

### Horses.

| | |
|---|---|
| Stallion for Agricultural purposes, of any age . . | Thirty Sovereigns. |
| Second-best ditto ditto . . | Fifteen Sovereigns. |
| Stallion for Agricultural purposes, two years old . | Twenty Sovereigns. |
| Second-best ditto ditto . . | Ten Sovereigns. |
| Stallion for Dray purposes . . . . . . . | Twenty Sovereigns. |
| Roadster . . . . . . . . . . . . | Fifteen Sovereigns. |
| Mare and Foal for Agricultural purposes . . . | Twenty Sovereigns. |
| Second-best ditto . ditto . . . | Ten Sovereigns. |
| Two-years-old Filly . . . . . . . . . | Fifteen Sovereigns. |
| Second-best ditto . . . . . . . . . . | Five Sovereigns. |

### Leicester Sheep.

| | |
|---|---|
| Shearling Ram . . . . . . . . . . | Thirty Sovereigns. |
| Second-best . . . . . . . . . . . | Fifteen Sovereigns. |
| Ram of any other age . . . . . . . . | Thirty Sovereigns. |
| Second-best ditto . . . . . . . . . . | Fifteen Sovereigns. |
| Pen of Five Shearling Ewes of the same flock . | Twenty Sovereigns. |
| Second-best ditto ditto . | Ten Sovereigns. |

### Southdown Sheep.

| | |
|---|---|
| Shearling Ram . . . . . . . . . . | Thirty Sovereigns. |
| Second-best . . . . . . . . . . . | Fifteen Sovereigns. |
| Ram of any other age . . . . . . . . | Thirty Sovereigns. |
| Second-best dittto . . . . . . . . . . | Fifteen Sovereigns. |
| Pen of Five Shearling Ewes of the same flock . | Twenty Sovereigns. |
| Second-best ditto ditto . | Ten Sovereigns. |

### Long-woolled Sheep (*not qualified to compete as Leicesters*).

| | |
|---|---|
| Shearling Ram . . . . . . . . . . | Thirty Sovereigns. |
| Second-best . . . . . . . . . . . | Fifteen Sovereigns. |
| Ram of any other age . . . . . . . . | Thirty Sovereigns. |
| Second-best ditto . . . . . . . . . . | Fifteen Sovereigns. |
| Pen of Five Shearling Ewes of the same flock . | Twenty Sovereigns. |
| Second-best ditto ditto . | Ten Sovereigns. |

### Pigs.

| | |
|---|---|
| Boar of large breed . . . . . . . . . | Fifteen Severeigns. |
| Second-best ditto . . . . . . . . . . | Five Sovereigns. |
| Boar of small breed . . . . . . . . . | Fifteen Sovereigns. |
| Second-best ditto . . . . . . . . . . | Five Sovereigns. |
| Breeding Sow of large breed . . . . . . . | Ten Sovereigns. |
| Breeding Sow of small breed . . . . . . . | Ten Sovereigns. |
| Pen of Three Breeding Sows of a large breed* . | Ten Sovereigns. |
| Pen of Three Breeding Sows of a small breed* . | Ten Sovereigns. |

* Of the same litter, above 4 and under 8 months old.